**UNITED STATES DEPARTMENT OF VETERANS AFFAIRS**

**PROJECT MANUAL**
**FOR**

# IRRIGATE ENTIRE CEMETERY
# CAMP BUTLER NATIONAL CEMETERY
# Springfield, Illinois

Project Number 806CM3024

**Final Construction Documents**
Prepared: January 28, 2014

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**DEPARTMENT OF VETERANS AFFAIRS**

**CAMP BUTLER NATIONAL CEMETERY**
**IRRIGATE ENTIRE CEMETERY**
**PROJECT NUMBER 806CM3024**

**TABLE OF CONTENTS**
**Section 00 01 10**

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**SECTION 00 01 15**

**LIST OF DRAWINGS**

The drawings listed below accompany the Specifications and form a part of the contract.

| Drawing No. | Title |
|---|---|
| I1.1 | Cover Index Sheet |
| I1.2 | Irrigation Notes and Legend |
| I1.3 | Irrigation Plan |
| I1.4 | Irrigation Plan |
| I1.5 | Irrigation Plan |
| I1.6 | Irrigation Plan |
| I1.7 | Irrigation Control and Phase Schematic |
| I1.8 | Irrigation Details |
| I1.9 | Irrigation Details |
| I1.10 | Irrigation Details |
| I1.11 | Irrigation Details |
| ESC1.1 | Erosion and Sediment Control Details |
| E1.1 | Electric - Symbols and One-Line |
| E1.2 | Electrical Site Plan – NW Quadrant |
| E1.3 | Electrical Site Plan – NE Quadrant |

- - - E N D - - -

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**SECTION 01 00 00**
**GENERAL REQUIREMENTS**

**TABLE OF CONTENTS**

# SECTION 01 00 00
# GENERAL REQUIREMENTS

## 1.1 GENERAL INTENTION

A. Contractor shall completely prepare site for construction and furnish labor and materials and perform work for irrigation system improvements at the Camp Butler National Cemetery as required by drawings and specifications.

B. Visits to the site by Bidders may be made only by appointment with the Cemetery Director.

C. All employees of general contractor and subcontractors shall comply with VA security management program and obtain permission of the VA Representative, be identified by project and employer, and restricted from unauthorized access.

D. Prior to commencing work, general contractor shall provide proof that a OSHA certified “competent person” (CP) (29 CFR 1926.20(b)(2) will maintain a presence at the work site whenever the general or subcontractors are present.

## 1.2 STATEMENT OF BID ITEM(S)

A. BASE BID ITEM 1, IRRIGATE ENTIRE CEMETERY: Work includes;

1. Protection of existing water service piping that services existing building,flower water stations and existing hydrants.

2. Installation of new irrigation system in the cemetery including mainline pipe; mainline valves and components; remote control valves, lateral pipe and sprinklers, satellite controllers and central control system; and resodding of areas disturbed by the construction.

3. Installation of a new prefabricated skid-mount booster pump station.

4. Provision of electrical power system to booster pump and satellite controllers.

5. Provide detailed Schedule of Values for Irrigation Components, see Appendix A.

**1.3 SPECIFICATIONS AND DRAWINGS FOR CONTRACTOR**

A. AFTER AWARD OF CONTRACT, two sets of specifications and drawings will be furnished.

B. Additional sets of drawings may be made by the Contractor, at Contractor's expense.

**1.4 FIRE SAFETY**

A. Applicable Publications: Publications listed below form part of this Article to extent referenced. Publications are referenced in text by basic designations only.

1. National Fire Protection Association (NFPA):

10-2006.....Standard for Portable Fire Extinguishers

30-2007.....Flammable and Combustible Liquids Code

51B-2003.....Standard for Fire Prevention During Welding, Cutting and Other Hot Work

70-2007.....National Electrical Code

241-2004.....Standard for Safeguarding Construction, Alteration, and Demolition Operations

2. Occupational Safety and Health Administration (OSHA):

29 CFR 1926.....Safety and Health Regulations for Construction

B. Site Access: Maintain free and unobstructed access to facility emergency services and for fire, Representative and other emergency response forces in accordance with NFPA 241.

C. Separate temporary facilities, such as trailers, storage sheds, and dumpsters, from existing buildings and new construction by distances in accordance with NFPA 241. For small facilities with less than 20 feet exposing overall length, separate by 10 feet.

D. Temporary Heating and Electrical: Install, use and maintain installations in accordance with 29 CFR 1926, NFPA 241 and NFPA 70.

E. Egress Routes for Construction Workers: Maintain free and unobstructed egress. Inspect daily. Report findings and corrective actions weekly to the COTR.

F. Fire Extinguishers: Provide and maintain extinguishers in construction areas and temporary storage areas in accordance with 29 CFR 1926, NFPA 241 and NFPA 10.

G. Flammable and Combustible Liquids: Store, dispense and use liquids in accordance with 29 CFR 1926, NFPA 241 and NFPA 30.

H. Fire Hazard Prevention and Safety Inspections: Inspect entire construction areas weekly. Coordinate with, and report findings and corrective actions weekly to the COTR.

I. Smoking: Smoking is prohibited on cemetery grounds and in and adjacent to construction areas, except in designated smoking rest areas.

J. Dispose of waste and debris in accordance with NFPA 241. Remove daily.

K. Perform other construction operations in accordance with 29 CFR 1926.

**1.5 OPERATIONS AND STORAGE AREAS**

A. The Contractor shall confine all operations (including storage of materials) on Government premises to areas authorized or approved by the Contracting Officer. The Contractor shall hold and save the

Government, its officers and agents, free and harmless from liability of any nature occasioned by the Contractor's performance.

B. Temporary buildings (e.g., storage sheds, shops, offices) and utilities may be erected by the Contractor only with the approval of the Contracting Officer and shall be built with labor and materials furnished by the Contractor without expense to the Government. The temporary buildings and utilities shall remain the property of the Contractor and shall be removed by the Contractor at its expense upon completion of the work. With the written consent of the Contracting Officer, the buildings and utilities may be abandoned and need not be removed.

C. The Contractor shall, under regulations prescribed by the Contracting Officer, use only established roadways, or use temporary roadways constructed by the Contractor when and as authorized by the Contracting Officer. When materials are transported in executing the work, vehicles shall not be loaded beyond the loading capacity recommended by the manufacturer of the vehicle or prescribed by any Federal, State, or local law or regulation. When it is necessary to cross curbs or sidewalks, the Contractor shall protect them from damage. The Contractor shall repair or pay for the repair of any damaged curbs, sidewalks, or roads.

D. Working space and space available for storing materials is extremely limited. Coordinate with the Cemetery Director and COTR for storage locations for construction materials.

E. Workmen are subject to rules of Cemetery applicable to their conduct.

F. Execute work so as to interfere as little as possible with normal functioning of Cemetery as a whole, including operations of utility services, fire protection systems and any existing equipment, and with work being done by others.

G. Construction Fence: Before construction operations begin, Contractor shall provide a chain link construction fence, seven feet minimum height, around the staging area indicated on the drawings. Provide gates as required for access with necessary hardware, including hasps and padlocks. Fasten fence fabric to terminal posts with tension bands and to line posts and top and bottom rails with tie wires spaced at maximum 15 inches. Bottom of fences shall extend to one inch above grade. Remove the fence when directed by VA COR.

H. Utilities Services: Maintain existing utility services for Cemetery at all times. Provide temporary facilities, labor, materials, equipment, connections, and utilities to assure uninterrupted services. Where necessary to cut existing water, steam, gases, sewer or air pipes, or conduits, wires, cables, etc. of utility services or of fire protection systems and communications systems (including telephone), they shall be cut and capped at suitable places where shown; or, in absence of such indication, where directed by the cemetery director and approved by COTR.

1. No utility service such as water, gas, steam, sewers or electricity, or fire protection systems and communications systems may be interrupted without prior approval of the COTR.

2. Contractor shall submit a request to interrupt any such services to the COTR, in writing, 48 hours in advance of proposed interruption. Request shall state reason, date, exact time of, and approximate duration of such interruption.

3. Contractor will be advised (in writing) of approval of request, or of which other date and/or time such interruption will cause least inconvenience to operations of Cemetery. Interruption time approved by the COTR may occur at other than Contractor's normal working hours.

4. Major interruptions of any system must be requested, in writing, at least 15 calendar days prior to the desired time and shall be performed as directed by the COTR.

5. In case of a contract construction emergency, service will be interrupted on approval of the COTR. Such approval will be confirmed in writing as soon as practical.

I. To minimize interference of construction activities with flow of Cemetery traffic, comply with the following:

1. Keep roads, walks and entrances to grounds, to parking and to occupied areas of buildings clear of construction materials, debris and standing construction equipment and vehicles.

2. Method and scheduling of required cutting, altering and removal of existing roads, walks and entrances must be approved by the COTR.

J. Coordination of Construction with Cemetery Director: The burial activities at a National Cemetery shall take precedence over construction activities. The Contractor must cooperate and coordinate with the Cemetery Director, through the COTR, in arranging construction schedule to cause the least possible interference with cemetery activities in actual burial areas. Construction noise during the interment services shall not disturb the service. Trucks and workmen shall not pass through the service area during this period:

1. The Contractor is required to discontinue his work sufficiently in advance of Easter Sunday, Mother's Day, Father's Day, Memorial Day, Veteran's Day and/or Federal holidays, to permit him to clean up all areas of operation adjacent to existing burial plots before these dates.

2. Cleaning up shall include the removal of all equipment, tools, materials and debris and leaving the areas in a clean, neat condition.

3. Check in with the Cemetery Director for burial services schedules when on-site before commencement of work each day or check with the cemetery administration office at the end of each day for the burial schedule of the following day.

## 1.6 PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT, UTILITIES, AND IMPROVEMENTS

A. The Contractor shall preserve and protect all structures, equipment, and vegetation (such as trees, shrubs, and grass) on or adjacent to the work site, which are not to be removed and which do not unreasonably interfere with the work required under this contract. The Contractor shall only remove trees when specifically authorized to do so, and shall avoid damaging vegetation that will remain in place. If any limbs or branches of trees are broken during contract performance, or by the careless operation of equipment, or by workmen, the Contractor shall trim those limbs or branches with a clean cut and paint the cut with a tree-pruning compound as directed by the Contracting Officer.

B. The Contractor shall protect from damage all existing improvements and utilities at or near the work site and on adjacent property of a third party, the locations of which are made known to or should be known by the Contractor. The Contractor shall repair any damage to those facilities, including those that are the property of a third party, resulting from failure to comply with the requirements of this contract or failure to exercise reasonable care in performing the work. If the Contractor fails or refuses to repair the damage promptly, the Contracting Officer may have the necessary work performed and charge the cost to the Contractor.

C. Refer to Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS, for additional requirements on protecting vegetation, soils and the environment. Refer to Articles, "Alterations", "Restoration", and "Operations and Storage Areas" for additional instructions concerning repair of damage to structures and site improvements.

**1.7 RESTORATION**

A. At Contractor's own expense, Contractor shall immediately restore to service and repair any damage caused by Contractor's workmen to existing piping and conduits, wires, cables, etc., of utility services or of fire protection systems and communications systems (including telephone) which are indicated on drawings and which are not scheduled for discontinuance or abandonment.

B. Expense of repairs to such utilities and systems not shown on drawings or locations of which are unknown will be covered by adjustment to contract time and price in accordance with clause entitled "CHANGES" (FAR 52.243-4 and VAAR 852.236-88) and "DIFFERING SITE CONDITIONS" (FAR 52.236-2) of Section 00 72 00, GENERAL CONDITIONS.

**1.8 PROFESSIONAL SURVEYING SERVICES**

A registered professional land surveyor or registered civil engineer whose services are retained and paid for by the Contractor shall perform services specified herein and in other specification sections. The Contractor shall certify that the land surveyor or civil engineer is not one who is a regular employee of the Contractor, and that the land surveyor or civil engineer has no financial interest in this contract.

**1.9 LAYOUT OF WORK**

A. Lay out work as directed by the Irrigation Specifications.

**1.10 AS-BUILT PROJECT RECORD DRAWINGS**

A. The contractor shall maintain two full size sets of as-built drawings which shall be kept current during construction of the project, to include all contract changes, modifications and clarifications.

B. All variations shall be shown in the same general detail as used in the contract drawings. To insure compliance, as-built drawings shall be made available for the COTR's and/or VA inspector’s review as often as requested.

C. Contractor shall deliver one approved completed set of as-built drawings to the COTR within 15 calendar days after the acceptance of the project by the COTR.

D. Contractor shall prepare the as-built drawings per section 32 84 00, 3.11.

E. Paragraphs A, B, & C shall also apply to all shop drawings.

**1.11 USE OF ROADWAYS**

A. For hauling, use only established public roads and roads on Cemetery property and, when authorized by the COTR, such temporary roads which are necessary in the performance of contract work. Temporary roads shall be constructed by the Contractor at Contractor's expense. When necessary to cross curbing, sidewalks, or similar construction, they must be protected by well-constructed bridges.

B. When new permanent roads are to be a part of this contract, Contractor may construct them immediately for use to facilitate building operations. These roads may be used by all who have business thereon within zone of building operations.

C. Existing roadway pavement and or curbing damaged by the contractor shall be repaired by the contractor at no expense to the VA.

**1.12 TEMPORARY TOILETS**

A. Provide where directed, (for use of all Contractor's workmen) ample temporary sanitary toilet accommodations. Keep such places clean and free from flies, and all connections and appliances connected therewith are to be removed prior to completion of contract, and premises left perfectly clean. Contractor shall keep such places clean and be responsible for any damage done thereto by Contractor's workmen. Failure to maintain satisfactory condition in toilets will deprive Contractor of the privilege to use such toilets.

**1.13 AVAILABILITY AND USE OF UTILITY SERVICES**

A. No temporary utilities will be provided by the Government.

B. No temporary construction trailer offices shall be sited on the construction project.

C. Electricity (for Construction and Testing): The Contractor shall furnish all temporary electric services.

**1.14 HISTORIC PRESERVATION**

Where the Contractor or any of the Contractor's employees, prior to, or during the construction work, are advised of or discover any possible archeological, historical and/or cultural resources, the Contractor shall immediately notify the COTR verbally, and then with a written follow up.

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**SECTION 01 32 17**

**NETWORK ANALYSIS SYSTEM - (MINOR PROJECTS)**
**(MICROSOFT PROJECT 2000 BARCHART )**

**1.1 DESCRIPTION:**

A. The Contractor shall develop a Microsoft Project 2000 (or later) Barchart schedule demonstrating fulfillment of the contract requirements. The Contractor shall keep the network up-to-date in accordance with the requirements of this section. The Contractor shall utilize the plan for scheduling, coordinating and monitoring work under this contract (including all activities of subcontractors, equipment vendors and suppliers). The Bar chart will be utilized to satisfy time applications.

**1.2 CONTRACTOR'S REPRESENTATIVE:**

A. The Contractor shall designate an in-house representative who will be responsible to prepare the schedule, review the schedule and report progress of the project to the Contracting Officer's Representative.

B. The Contractor's in-house representative shall be given authority to act on behalf of the Contractor in fulfilling the requirements of this specification section. Such authority shall not be interrupted throughout the duration of the project.

**1.3 COMPUTER PRODUCED SCHEDULES:**

A. The contractor shall provide to the VA monthly computer processing of all computer produced schedules generated from monthly project updates. The Contractor will provide to the VA two (2) copies of the updated Microsoft Project BarChart and an electronic copy of this data. This must be submitted with and substantively support the contractor's monthly payment request.

B. The Contractor is responsible for the correctness and timeliness of the computer-produced reports. The Contractor is also responsible for the accurate and timely submittal of the updated project schedule.

C. The VA shall report errors in computer-produced reports to the Contractor's representative within ten (10) calendar days from receipt of reports. The Contractor will reprocess the BarChart

and associated CDs, when requested by the Contracting Officers Representative, to correct errors that affect the schedule for the project.

**1.4 THE COMPLETE PROJECT BARCHART SUBMITTAL:**

A. The Complete Project Microsoft Project BarChart will contain approximately (10) work activities / events.

B. Within thirty (30) calendar days after receipt of the Contract Award, the Contractor shall submit for the Contracting Officer's review, a Microsoft Project BarChart and a CD. Each activity/event on the BarChart schedule shall contain as a minimum, but not limited to, activity/event description, duration, start dates and finish dates. Activity constraints, not required by the contract, will not be accepted. Logic events (non-work) will be permitted where necessary to reflect proper sequence among work events, but must have zero duration.

C. The complete working BarChart shall reflect the Contractor's approach to scheduling the complete project. The final BarChart in its original form shall contain no contract changes or delays that may have been incurred during the final BarChart development period. It shall reflect the Contractors "AS BID" or "DAY 1" schedule. Changes and /or delays shall be entered at the first monthly update after the final BarChart has been approved. The Contractor should provide their requests for time and supporting time extension analysis for contract time as a result of contract changes/delays, after this update, and in accordance with Article, ADJUSTMENT OF CONTRACT COMPLETION.

D. Within ten (10) calendar days after receipt of the complete project BarChart, the Contracting Officer or his representative, will do one or both of the following:

1. Notify the Contractor concerning his actions, opinions, and objections.
2. Schedule a meeting with the Contractor at, or near the job site, for joint review, correction or adjustment of the proposed plan. Within ten (10) calendar days after the joint review, the Contractor shall revise and shall submit two (2) copies of the revised BarChart and a revised CD as specified

to the Contracting Officer. The revised submission will be reviewed by the Contracting Officer and, if found to be as previously agreed upon, will be approved.

**1.5 WORK ACTIVITY/EVENT AND COST DATA INFORMATION:**

A. The Contractor will not be required to “cost load” the computerized Microsoft Project BarChart. As part of this submission, the Contractor shall provide a separate **Schedule of Costs** matrix. This Schedule of Costs shall reflect and contain all the same activities/events identified on the BarChart.

B. The Contractor and the Contracting Officer shall use this Schedule of Costs for monthly payment purposes as referenced in the General Conditions of this agreement.

C. The Contractor and Contracting Officer shall agree on percentages for monthly work accomplished. The cumulative total amount of all cost loaded activities/events (including alternates) shall equal the total contract price.

D. Prorate overhead, profit and general conditions on all work activities/events for the entire project. Negative work activity/event cost data will not be acceptable, except on VA issued contract changes.

**1.6 BARCHART REQUIREMENTS**:

A. Show on the BarChart the sequence and interdependence of work activities/events required for complete performance of all items of work. In preparing the BarChart , the Contractor shall:

1. Show the following on each work activity/event:
   a. Concise description of the work represented by the activity/event.
   b. Duration (in work days.)
2. Show activities/events as:
   a. Contractor's time required for submittal of shop drawings, templates, fabrication, delivery and similar pre-construction work.
   b. Contracting Officer Representative's and Architect-Engineer's review and approval of shop drawings, equipment schedules, samples, template, or similar items.

c. Interruption of VA Cemetery utilities, delivery of Government furnished equipment, project phasing and any other specification requirements.

d. Test, balance and adjust various systems and pieces of equipment.

3. Break up the work into activities/events of durations no longer than thirty (30) work days each, except as to non-construction activities/events (i.e., procurement of materials, delivery of equipment, concrete and asphalt curing) and any other activities/events for which the Contracting Officer may approve the showing of a longer duration. [The duration for VA approval of any required submittal, shop drawing, or other submittals shall not be less than ten (10) workdays.] The construction time as determined by the BarChart schedule from start to finish for any sub-phase, phase or the entire project shall not exceed the total contract duration. Describe work activities/events clearly, so the work is readily identifiable for assessment of completion. Activities/events labeled "start," "continue," or "completion," are not specific and will not be allowed. Lead and lag time activities will not be acceptable.

4. Exterior Label Information:
Provide the following information on an external label attached to each diskette(s):

a. VA project number and project location.

b. Name and telephone number of a point of contact, preferably the person who created the CD

c. The CD number and total number of CDs in the set

d. The project data status date.

**1.7 PAYMENT TO THE CONTRACTOR:**

A. Monthly, the contractor shall submit the BarChart updated for remaining activity durations and a Schedule of Costs updated for costs. AIA application and certification for payment documents G702 and G703 may be used. The payment request should reflect and be in accordance with the provisions of the following Article, PAYMENT AND PROGRESS REPORTING, as the basis upon which

progress payments will be made pursuant to Article, PAYMENT UNDER FIXED-PRICE CONSTRUCTION CONTRACTS of Section GENERAL CONDITIONS. The Contractor is entitled to a monthly progress payment upon approval of estimates as determined from the currently approved updated Schedule of Costs unless, in special situations, the Contracting Officer permits an exception to this requirement. Monthly payment requests shall include: two (2) copies of the updated Microsoft Project Bar Chart, a listing of all project schedule changes, and associated data, made at the update; and CDs of the resulting monthly updated schedule. These must be submitted with and substantively support the contractor’s monthly application and certificate for payment request documents.

B. When the Contractor fails or refuses to furnish to the Contracting Officer the information and the associated updated Bar Chart data on CDs, which, in the sole judgment of the Contracting Officer, are necessary for validating the monthly progress payment, the Contractor shall not be deemed to have provided supporting schedule data upon which progress payment may be reasonably determined.

**1.8 PAYMENT AND PROGRESS REPORTING:**

A. Monthly job site progress meetings shall be held on dates mutually agreed to by the Contracting Officer (or Contracting Officer's Technical Representative) and the Contractor. Presence of subcontractors during the progress meeting is optional unless required by the Contracting Officer (or Contracting Officer's Representative). Job progress will be reviewed to verify:

1. Actual start and/or finish dates for updated/completed activities/events.
2. Remaining duration, required to complete each activity/event started, or scheduled to start, but not completed.
3. Time and cost data for change orders, and supplemental agreements that are to be incorporated into the BarChart.
4. Percentage for completed and partially completed activities/events.
5. Logic and duration revisions required by this section of the specifications.

6. Activity/event duration and percent complete shall be updated independently.

B. The Contractor shall submit a narrative report as a part of his monthly review and update, in a form agreed upon by the Contracting Officer. The narrative report shall include a description of problem areas; current and anticipated delaying factors and their estimated impact on performance of other activities/events and completion dates; and an explanation of corrective action taken or proposed. This report is in addition to the daily reports pursuant to the provisions of Article, DAILY REPORT OF WORKERS AND MATERIALS in the GENERAL CONDITIONS.

C. As part of the monthly jobsite progress meeting, the General Contractor, specifically requested subcontractors and the Contracting Officers Representative shall meet to discuss the monthly updated schedule. The main emphasis shall be to address work activities to avoid slippage of project schedule and to identify any necessary actions required to maintain project schedule during the reporting period.

**1.9 RESPONSIBILITY FOR COMPLETION:**

A. Whenever it becomes apparent from the monthly progress review meeting or the monthly computer-produced BarChart schedule that phasing or contract completion dates will not be met, the Contractor shall execute some or all of the following remedial actions:

1. Increase construction manpower in such quantities and crafts as necessary to eliminate the backlog of work.
2. Increase the number of working hours per shift, shifts per working day, working days per week, the amount of construction equipment, or any combination of the foregoing to eliminate the backlog of work.
3. Reschedule the work in conformance with the specification requirements.

B. Prior to proceeding with any of the above actions, the Contractor shall notify and obtain approval from the Contracting Officer for the proposed schedule changes. If such actions are approved, the revisions shall be incorporated by the Contractor into the

BarChart before the next update, at no additional cost to the Government.

**1.10 CHANGES TO BARCHART SCHEDULE:**

A. Within ten (10) calendar days after VA acceptance and approval of any updated computer-produced schedule, the Contractor will submit a revised BarChart, the associated CDs, and a list of any activity/event changes including predecessors and successors for any of the following reasons:

1. Delay in completion of any activity/event or group of activities/events, which indicate an extension of the project completion by twenty (20) working days or 10 percent of the remaining project duration, whichever is less. Such delays which may be involved with contract changes, strikes, unusual weather, and other delays will not relieve the Contractor from the requirements specified unless the conditions are shown on the BarChart as the direct cause for delaying the project beyond the acceptable limits.
2. Delays in submittals, or deliveries, or work stoppage are encountered which make rescheduling of the work necessary.
3. The schedule does not represent the actual prosecution and progress of the project.
4. When there is, or has been, a substantial revision to the activity/event costs of the network diagram regardless of the cause for these revisions.

B. Revisions made under this paragraph, which affect the previously approved computer-produced schedules for Government furnished equipment, contract phase(s) and sub phase(s), utilities furnished by the Government to the Contractor, or any other previously contracted item, must be furnished in writing to the Contracting Officer for approval.

C. Contracting Officer's approval for the revised network diagram and all relevant data is contingent upon compliance with all other paragraphs of this section and any other previous agreements by the Contracting Officer or the Contracting Officer’s Representative.

D. The cost of revisions to the BarChart resulting from contract changes will be included in the cost of the change.

E. The cost of revisions to the BarChart not resulting from contract changes is the responsibility of the Contractor.

**1.11 ADJUSTMENT OF CONTRACT COMPLETION:**

A. The contract completion time will be adjusted only for causes specified in this contract. Request for an extension of the contract completion date by the Contractor shall be supported with a justification, BarChart data and supporting evidence as the Contracting Officer may deem necessary for determination as to whether or not the Contractor is entitled to an extension of time under the provisions of the contract. Submission of proof based on revised activity/event logic, durations (in work days) and costs is obligatory to any approvals.

B. The Contracting Officer's determination as to the total number of days of contract extension will be based upon the current computer-produced BarChart schedule for the time period when the change took place and all other relevant information. The Contracting Officer will, within thirty (30) calendar days after receipt of such justification and supporting evidence, advise the Contractor in writing of his decision on the matter.

C. The Contractor shall submit each request for a change in the contract completion date to the Contracting Officer in accordance with the provisions specified under Article, CHANGES, in the Section, GENERAL CONDITIONS. The Contractor shall include, as a part of each change order proposal, a sketch showing all revisions, duration (in work days) changes, and cost changes, for work in question and its relationship to other activities on the approved network diagram.

D. All delays due to non-work activities/events such as RFI’s, WEATHER, STRIKES, and similar non-work activities/events shall be analyzed on a month by month basis.

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**SECTION 01 33 23**
**SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES**

**PART 1 - GENERAL**

1.1 Refer to Articles titled SPECIFICATIONS AND DRAWINGS FOR CONSTRUCTION (FAR 52.236-21) and, SPECIAL NOTES (VAAR 852.236-91), in GENERAL CONDITIONS.

1.2 For the purposes of this contract, samples, test reports, certificates, and manufacturers' literature and data shall also be subject to the previously referenced requirements. The following text refers to all items collectively as SUBMITTALS.

1.3 Submit for approval, all of the items specifically mentioned under the separate sections of the specification, with information sufficient to evidence full compliance with contract requirements. Materials, fabricated articles and the like to be installed in permanent work shall equal those of approved submittals. After an item has been approved, no change in brand or make will be permitted unless:

A. Satisfactory written evidence is presented to, and approved by Contracting Officer, that manufacturer cannot make scheduled delivery of approved item or;

B. Item delivered has been rejected and substitution of a suitable item is an urgent necessity or;

C. Other conditions become apparent which indicates approval of such substitute item to be in best interest of the Government.

1.4 Forward submittals in sufficient time to permit proper consideration and approval action by Government. Time submission to assure adequate lead time for procurement of contract - required items. Delays attributable to untimely and rejected submittals will not serve as a basis for extending contract time for completion.

A. For each submittal for review, allow 15 calendar days excluding delivery time to and from the Contractor.

1.5 Submittals will be reviewed for compliance with contract requirements by Architect-Engineer, and action thereon will be taken by the COTR on behalf of the Contracting Officer.

1.6 Upon receipt of submittals, the COTR will assign a file number thereto. Contractor, in any subsequent correspondence, shall refer to this file

and identification number to expedite replies relative to previously approved or disapproved submittals.

1.7 The Government reserves the right to require additional submittals, whether or not particularly mentioned in this contract. If additional submittals beyond those required by the contract are furnished pursuant to request therefor by Contracting Officer, adjustment in contract price and time will be made in accordance with Articles titled CHANGES (FAR 52.243-4) and CHANGES - SUPPLEMENT (VAAR 852.236-88) of the GENERAL CONDITIONS.

1.8 Schedules called for in specifications and shown on shop drawings shall be submitted for use and information of Department of Veterans Affairs and the COTR. However, the Contractor shall assume responsibility for coordinating and verifying schedules. The Contracting Officer and Architect- Engineer assumes no responsibility for checking schedules or layout drawings for exact sizes, exact numbers and detailed positioning of items.

1.9 Submittals must be submitted by Contractor only and shipped prepaid. Contracting Officer assumes no responsibility for checking quantities or exact numbers included in such submittals.

A. Submit samples in single units unless otherwise specified. Submit shop drawings, schedules, manufacturers' literature and data, and certificates in quadruplicate, except where a greater number is specified.

B. Submittals will receive consideration only when covered by a transmittal letter signed by Contractor. Letter shall be sent via first class mail and shall contain the list of items, name of Cemetery, name of Contractor, contract number, applicable specification paragraph numbers, applicable drawing numbers (and other information required for exact identification of location for each item), manufacturer and brand, ASTM or Federal Specification Number (if any) and such additional information as may be required by specifications for particular item being furnished. In addition, catalogs shall be marked to indicate specific items submitted for approval.

1. A copy of letter must be enclosed with items, and any items received without identification letter will be considered "unclaimed goods" and held for a limited time only.

2. Each sample, certificate, manufacturers' literature and data shall be labeled to indicate the name and location of the Cemetery, name of Contractor, manufacturer, brand, contract number and ASTM or Federal Specification Number as applicable and location(s) on project.
3. Required certificates shall be signed by an authorized representative of manufacturer or supplier of material, and by Contractor.

C. In addition to complying with the applicable requirements specified in preceding Article 1.9, samples which are required to have Laboratory Tests (those preceded by symbol "LT" under the separate sections of the specification shall be tested, at the expense of Contractor, in a commercial laboratory approved by Contracting Officer.
1. Samples and laboratory tests shall be sent directly to approved commercial testing laboratory.
2. Contractor shall forward a copy of transmittal letter to the COTR simultaneously with submission to a commercial testing laboratory.
3. Laboratory test reports shall be sent directly to the COTR for appropriate action.
4. Laboratory reports shall list contract specification test requirements and a comparative list of the laboratory test results. When tests show that the material meets specification requirements, the laboratory shall so certify on test report.
5. Laboratory test reports shall also include a recommendation for approval or disapproval of tested item.

D. Submittal drawings (shop, erection or setting drawings) and schedules, required for work of various trades, shall be checked before submission by technically qualified employees of Contractor for accuracy, completeness and compliance with contract requirements. These drawings and schedules shall be stamped and signed by Contractor certifying to such check.
1. For each drawing required, submit one legible photographic paper or vellum reproducible.
2. Reproducible shall be full size.
3. Each drawing shall have marked thereon, proper descriptive title, including Cemetery location, project number, manufacturer's number,

reference to contract drawing number, detail Section Number, and Specification Section Number.

4. A space 4-3/4 by 5 inches shall be reserved on each drawing to accommodate approval or disapproval stamp.
5. Submit drawings, ROLLED WITHIN A MAILING TUBE, fully protected for shipment.
6. One reproducible print of approved or disapproved shop drawings will be forwarded to Contractor.
7. When work is directly related and involves more than one trade, shop drawings shall be submitted to the COTR under one cover.

1.10 Samples, shop drawings, test reports, certificates and manufacturers' literature and data, shall be submitted for approval to the COTR.

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# SECTION 01 45 29
# TESTING LABORATORY SERVICES

## PART 1 - GENERAL

### 1.1 DESCRIPTION:

This section specifies materials testing activities and inspection services required during project construction to be provided by a Testing Laboratory retained and paid for by Contractor.

### 1.2 APPLICABLE PUBLICATIONS:

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

B. ASTM International (ASTM):

D698.....Standard Test methods for Laboratory Compaction Characteristics of Soil Using Standard Effort

D1556.....Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method

D2937.....Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method

D2974.....Standard Test methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils

D3740.....Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock Used in Engineering Design and Construction

D6938.....Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

E329.....Standard Specification for Agencies Engaged in Construction Inspection and/or Testing

### 1.3 REQUIREMENTS:

A. Accreditation Requirements: Testing Laboratory retained and paid for by Contractor, must be accredited by one or more of the National Voluntary Laboratory Accreditation Program (NVLAP) programs acceptable in the geographic region for the project. Furnish to the Contracting Officer a copy of the Certificate of Accreditation and Scope of Accreditation. For testing laboratories that have not yet obtained accreditation by a NVLAP program, submit an acknowledgement letter from one of the

laboratory accreditation authorities indicating that the application for accreditation has been received and the accreditation process has started, and submit to the Contracting Officer for approval, certified statements, signed by an official of the testing laboratory attesting that the proposed laboratory, meets or conforms to the ASTM standards listed below as appropriate to the testing field.

1. Laboratories engaged in testing of construction materials shall meet the requirements of ASTM E329.
2. Laboratories engaged in testing of soil and rock, as used in engineering design and construction, shall meet the requirements of ASTM D3740.

B. Inspection and Testing: Testing laboratory shall inspect materials and workmanship and perform tests described herein and additional tests requested by the COTR. When it appears materials furnished, or work performed by Contractor fail to meet construction contract requirements, Testing Laboratory shall direct attention of the COTR to such failure.

C. Written Reports: Testing laboratory shall submit test reports to the COTR, and Contractor within 24 hours after each test is completed unless other arrangements are agreed to in writing by the COTR. Submit reports of tests that fail to meet construction contract requirements on colored paper.

D. Verbal Reports: Give verbal notification to the COTR immediately of any irregularity.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION**

**3.1 LANDSCAPING**:

A. Test topsoil for organic materials, pH, phosphate, potash content, and gradation of particles.

1. Test for organic material by using ASTM D2974.
2. Determine percent of silt, sand, clay, and foreign materials such as rock, roots, and vegetation.

B. Submit laboratory test report of topsoil to the COTR.

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# SECTION 01 57 19
# TEMPORARY ENVIRONMENTAL CONTROLS

## 1.1. DESCRIPTION

A. This section specifies the control of environmental pollution and damage that the Contractor must consider for air, water, and land resources. It includes management of visual aesthetics, noise, solid waste, radiant energy, and radioactive materials, as well as other pollutants and resources encountered or generated by the Contractor. The Contractor is obligated to consider specified control measures with the costs included within the various contract items of work.

B. Environmental pollution and damage is defined as the presence of chemical, physical, or biological elements or agents which:
   1. Adversely effect human health or welfare,
   2. Unfavorably alter ecological balances of importance to human life,
   3. Effect other species of importance to humankind, or;
   4. Degrade the utility of the environment for aesthetic, cultural, and historical purposes.

C. Definitions of Pollutants:
   1. Chemical Waste: Petroleum products, bituminous materials, salts, acids, alkalis, herbicides, pesticides, organic chemicals, and inorganic wastes.
   2. Debris: Combustible and noncombustible wastes, such as leaves, tree trimmings, ashes, and waste materials resulting from construction or maintenance and repair work.
   3. Sediment: Soil and other debris that has been eroded and transported by runoff water.
   4. Solid Waste: Rubbish, debris, garbage, and other discarded solid materials resulting from industrial, commercial, and agricultural operations and from community activities.
   5. Surface Discharge: The term "Surface Discharge" implies that the water is discharged with possible sheeting action and subsequent soil erosion may occur. Waters that are surface discharged may terminate in drainage ditches, storm sewers, creeks, and/or "water of the United States" and would require a permit to discharge water from the governing agency.
   6. Rubbish: Combustible and noncombustible wastes such as paper, boxes, glass and crockery, metal and lumber scrap, and tin cans.

7. Sanitary Wastes:
   a. Sewage: Domestic sanitary sewage and human and animal waste.
   b. Garbage: Refuse and scraps resulting from preparation, cooking, dispensing, and consumption of food.

**1.2. QUALITY CONTROL**

A. Establish and maintain quality control for the environmental protection of all items set forth herein.

B. Record on daily reports any problems in complying with laws, regulations, and ordinances. Note any corrective action taken.

**1.3. REFERENCES**

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. U.S. National Archives and Records Administration (NARA):
33 CFR 328 Definitions

**1.4. SUBMITTALS**

A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:

1. Environmental Protection Plan: After the contract is awarded and prior to the commencement of the work, the Contractor shall meet with the COTR to discuss the proposed Environmental Protection Plan and to develop mutual understanding relative to details of environmental protection. Not more than 20 days after the meeting, the Contractor shall prepare and submit to the COTR for approval, a written and/or graphic Environmental Protection Plan including, but not limited to, the following:
   a. Name(s) of person(s) within the Contractor's organization who is (are) responsible for ensuring adherence to the Environmental Protection Plan.
   b. Name(s) and qualifications of person(s) responsible for training the Contractor's environmental protection personnel.
   c. Description of the Contractor's environmental protection personnel training program.
   d. A list of Federal, State, and local laws, regulations, and permits concerning environmental protection, pollution control, noise control and abatement that are applicable to the Contractor's proposed operations and the requirements imposed by those laws, regulations, and permits.

e. Methods for protection of features to be preserved within authorized work areas including trees, shrubs, vines, grasses, ground cover, landscape features, air and water quality, fish and wildlife, soil, historical, and archeological and cultural resources.

f. Procedures to provide the environmental protection that comply with the applicable laws and regulations. Describe the procedures to correct pollution of the environment due to accident, natural causes, or failure to follow the procedures as described in the Environmental Protection Plan.

g. Permits, licenses, and the location of the solid waste disposal area.

h. Drawings showing locations of any proposed temporary excavations or embankments for haul roads, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials.

k. Environmental Monitoring Plans for the job site including land, water, air, and noise.

l. Work Area Plan showing the proposed activity in each portion of the area and identifying the areas of limited use or nonuse. Plan should include measures for marking the limits of use areas.

B. Approval of the Contractor's Environmental Protection Plan will not relieve the Contractor of responsibility for adequate and continued control of pollutants and other environmental protection measures.

**1.5. PROTECTION OF ENVIRONMENTAL RESOURCES**

A. Protect environmental resources within the project boundaries and those affected outside the limits of permanent work during the entire period of this contract. Confine activities to areas defined by the specifications and drawings.

B. Protection of Land Resources: Prior to construction, identify all land resources to be preserved within the work area. Do not remove, cut, deface, injure, or destroy land resources including trees, shrubs, vines, grasses, top soil, and land forms without permission from the COTR. Do not fasten or attach ropes, cables, or guys to trees for anchorage unless specifically authorized, or where special emergency use is permitted.

1. Work Area Limits: Prior to any construction, mark the areas that require work to be performed under this contract. Mark or fence

isolated areas within the general work area that are to be saved and protected. Protect monuments, works of art, and markers before construction operations begin. Convey to all personnel the purpose of marking and protecting all necessary objects.

2. Protection of Landscape: Protect trees, shrubs, vines, grasses, land forms, and other landscape features shown on the drawings to be preserved by marking, fencing, or using any other approved techniques.
   a. Box and protect from damage existing trees and shrubs to remain on the construction site.
   b. Immediately repair all damage to existing trees and shrubs by trimming, cleaning, and painting with antiseptic tree paint.
   c. Do not store building materials or perform construction activities closer to existing trees or shrubs than the farthest extension of their limbs.
3. Reduction of Exposure of Unprotected Erodible Soils: Plan and conduct earthwork to minimize the duration of exposure of unprotected soils. Clear areas in reasonably sized increments only as needed to use. Form earthwork to final grade as shown. Immediately protect side slopes and back slopes upon completion of rough grading.
4. Temporary Protection of Disturbed Areas: Construct diversion ditches, benches, and berms as necessary to retard and divert runoff from the construction site to protected drainage areas approved under paragraph 208 of the Clean Water Act.
5. Erosion and Sedimentation Control Devices: The erosion and sediment controls installed and maintained by the Contractor shall be such that water quality standards are not violated as a result of the Contractor's activities. Construct or install all temporary and permanent erosion and sedimentation control features shown on the Drawings or as otherwise approved by the COTR. Maintain temporary erosion and sediment control measures such as berms, dikes, drains, sedimentation basins, grassing, and mulching, until permanent drainage and erosion control facilities are completed and operative.
6. Manage borrow areas on Government property to minimize erosion and to prevent sediment from entering nearby water courses or lakes.
7. Protect adjacent areas from despoilment by temporary excavations and embankments.

8. Handle and dispose of solid wastes in such a manner that will prevent contamination of the environment. Place solid wastes (excluding clearing debris) in containers that are emptied on a regular schedule. Transport all solid waste off Government property and dispose of waste in compliance with Federal, State, and local requirements.
9. Store chemical waste away from the work areas in corrosion resistant containers and dispose of waste in accordance with Federal, State, and local regulations.
10. Handle discarded materials other than those included in the solid waste category as directed by the COTR.

C. Protection of Water Resources: Keep construction activities under surveillance, management, and control to avoid pollution of surface and ground waters and sewer systems. Implement management techniques to control water pollution by the listed construction activities that are included in this contract.
   1. Washing and Curing Water: Do not allow wastewater directly derived from construction activities to enter water areas.
   2. Monitor water areas affected by construction.

D. Protection of Fish and Wildlife Resources: Keep construction activities under surveillance, management, and control to minimize interference with, disturbance of, or damage to fish and wildlife. Prior to beginning construction operations, list species that require specific attention along with measures for their protection.

E. Protection of Air Resources: Keep construction activities under surveillance, management, and control to minimize pollution of air resources. Burning is not permitted on the job site. Keep activities, equipment, processes, and work operated or performed, in strict accordance with the State of Illinois and Federal emission and performance laws and standards. Maintain ambient air quality standards set by the Environmental Protection Agency, for those construction operations and activities specified.
   1. Particulates: Control dust particles, aerosols, and gaseous by-products from all construction activities, processing, and preparation of materials (such as from asphaltic batch plants) at all times, including weekends, holidays, and hours when work is not in progress.

2. Particulates Control: Maintain all excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and all other work areas within or outside the project boundaries free from particulates which would cause a hazard or a nuisance. Sprinklering, chemical treatment of an approved type, light bituminous treatment, baghouse, scrubbers, electrostatic precipitators, or other methods are permitted to control particulates in the work area.
3. Hydrocarbons and Carbon Monoxide: Control monoxide emissions from equipment to Federal and State allowable limits.
4. Odors: Control odors of construction activities and prevent obnoxious odors from occurring.

F. Reduction of Noise: Minimize noise using every action possible. Perform noise-producing work in less sensitive hours of the day or week as directed by the COTR. Maintain noise-produced work at or below the decibel levels and within the time periods specified.

1. Perform construction activities involving repetitive, high-level impact noise only between 8:00 a.m. and 6:00 p.m unless otherwise permitted by local ordinance or the COTR and as discussed in Section 01 00 00, GENERAL REQUIREMENTS, subsection 1.5.J. Repetitive impact noise on the property shall not exceed the following dB limitations:

| Time Duration of Impact Noise | Sound Level in dB |
|---|---|
| More than 12 minutes in any hour | 70 |
| Less than 30 seconds of any hour | 85 |
| Less than three minutes of any hour | 80 |
| Less than 12 minutes of any hour | 75 |

2. Provide sound-deadening devices on equipment and take noise abatement measures that are necessary to comply with the requirements of this contract, consisting of, but not limited to, the following:
   a. Maintain maximum permissible construction equipment noise levels at 15 m (50 feet) (dBA):

| EARTHMOVING | | MATERIALS HANDLING | |
|---|---|---|---|
| FRONT LOADERS | 75 | CONCRETE MIXERS | 75 |
| BACKHOES | 75 | CONCRETE PUMPS | 75 |
| DOZERS | 75 | CRANES | 75 |

| | | | |
|---|---|---|---|
| TRACTORS | 75 | DERRICKS IMPACT | 75 |
| SCAPERS | 80 | PILE DRIVERS | 95 |
| GRADERS | 75 | JACK HAMMERS | 75 |
| TRUCKS | 75 | ROCK DRILLS | 80 |
| PAVERS, STATIONARY | 80 | PNEUMATIC TOOLS | 80 |
| PUMPS | 75 | | |
| GENERATORS | 75 | SAWS | 75 |
| COMPRESSORS | 75 | VIBRATORS | 75 |

b. Use shields or other physical barriers to restrict noise transmission.

c. Provide soundproof housings or enclosures for noise-producing machinery.

d. Use efficient silencers on equipment air intakes.

e. Use efficient intake and exhaust mufflers on internal combustion engines that are maintained so equipment performs below noise levels specified.

f. Line hoppers and storage bins with sound deadening material.

g. Conduct truck loading, unloading, and hauling operations so that noise is kept to a minimum.

3. Measure sound level for noise exposure due to the construction at least once every five successive working days while work is being performed above 55 dB(A) noise level. Measure noise exposure at the property line or 50 feet from the noise source, whichever is greater. Measure the sound levels on the A weighing network of a General Purpose sound level meter at slow response. To minimize the effect of reflective sound waves at buildings, take measurements at three to six feet in front of any building face. Submit the recorded information to the COTR noting any problems and the alternatives for mitigating actions.

G. Restoration of Damaged Property: If any direct or indirect damage is done to public or private property resulting from any act, omission, neglect, or misconduct, the Contractor shall restore the damaged property to a condition equal to that existing before the damage at no additional cost to the Government. Repair, rebuild, or restore property as directed or make good such damage in an acceptable manner.

H. Final Clean-up: On completion of project and after removal of all debris, rubbish, and temporary construction, Contractor shall leave the construction area in a clean condition satisfactory to the COTR. Cleaning shall include off the station disposal of all items and materials not required to be salvaged, as well as all debris and rubbish resulting from demolition and new work operations.

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# SECTION 01 74 19
# CONSTRUCTION WASTE MANAGEMENT

## PART 1 – GENERAL

### 1.1 DESCRIPTION

A. This section specifies the requirements for the management of non-hazardous building construction and demolition waste.

B. Waste disposal in landfills shall be minimized to the greatest extent possible. Of the inevitable waste that is generated, as much of the waste material as economically feasible shall be salvaged, recycled or reused.

C. Contractor shall use all reasonable means to divert construction and demolition waste from landfills and incinerators, and facilitate their salvage and recycle not limited to the following:

1. Waste Management Plan development and implementation.
2. Techniques to minimize waste generation.
3. Sorting and separating of waste materials.
4. Salvage of existing materials and items for reuse or resale.
5. Recycling of materials that cannot be reused or sold.

D. At a minimum the following waste categories shall be diverted from landfills:

1. Soil.
2. Inerts (eg, concrete, masonry and asphalt).
3. Clean dimensional wood and palette wood.
4. Green waste (biodegradable landscaping materials).
5. Engineered wood products (plywood, particle board and I-joists, etc).
6. Metal products (eg, steel, wire, beverage containers, copper, etc).
7. Cardboard, paper and packaging.
8. Bitumen roofing materials.
9. Plastics (eg, ABS, PVC).

### 1.2 RELATED WORK

A. Section 01 00 00, GENERAL REQUIREMENTS.

### 1.3 QUALITY ASSURANCE

A. Contractor shall practice efficient waste management when sizing, cutting and installing products. Processes shall be employed to ensure the generation of as little waste as possible. Construction /Demolition waste includes products of the following:

1. Excess or unusable construction materials.

2. Packaging used for construction products.
3. Poor planning and/or layout.
4. Construction error.
5. Over ordering.
6. Weather damage.
7. Contamination.
8. Mishandling.
9. Breakage.

B. Establish and maintain the management of non-hazardous building construction and demolition waste set forth herein. Conduct a site assessment to estimate the types of materials that will be generated by demolition and construction.

C. Contractor shall develop and implement procedures to recycle construction and demolition waste to a minimum of 50 percent.

D. Contractor shall be responsible for implementation of any special programs involving rebates or similar incentives related to recycling. Any revenues or savings obtained from salvage or recycling shall accrue to the contractor.

E. Contractor shall provide all demolition, removal and legal disposal of materials. Contractor shall ensure that facilities used for recycling, reuse and disposal shall be permitted for the intended use to the extent required by local, state, federal regulations. The Whole Building Design Guide website http://www.cwm.wbdg.org provides a Construction Waste Management Database that contains information on companies that haul, collect, and process recyclable debris from construction projects.

F. Contractor shall assign a specific area to facilitate separation of materials for reuse, salvage, recycling, and return. Such areas are to be kept neat and clean and clearly marked in order to avoid contamination or mixing of materials.

G. Contractor shall provide on-site instructions and supervision of separation, handling, salvaging, recycling, reuse and return methods to be used by all parties during waste generating stages.

H. Record on daily reports any problems in complying with laws, regulations and ordinances with corrective action taken.

**1.4 TERMINOLOGY**

A. Class III Landfill: A landfill that accepts non-hazardous resources such as household, commercial and industrial waste resulting from construction, remodeling, repair and demolition operations.

B. Clean: Untreated and unpainted; uncontaminated with adhesives, oils, solvents, mastics and like products.

C. Construction and Demolition Waste: Includes all non-hazardous resources resulting from construction, remodeling, alterations, repair and demolition operations.

D. Dismantle: The process of parting out a building in such a way as to preserve the usefulness of its materials and components.

E. Disposal: Acceptance of solid wastes at a legally operating facility for the purpose of land filling (includes Class III landfills and inert fills).

F. Inert Backfill Site: A location, other than inert fill or other disposal facility, to which inert materials are taken for the purpose of filling an excavation, shoring or other soil engineering operation.

G. Inert Fill: A facility that can legally accept inert waste, such as asphalt and concrete exclusively for the purpose of disposal.

H. Inert Solids/Inert Waste: Non-liquid solid resources including, but not limited to, soil and concrete that does not contain hazardous waste or soluble pollutants at concentrations in excess of water-quality objectives established by a regional water board, and does not contain significant quantities of decomposable solid resources.

I. Mixed Debris: Loads that include commingled recyclable and non-recyclable materials generated at the construction site.

J. Mixed Debris Recycling Facility: A solid resource processing facility that accepts loads of mixed construction and demolition debris for the purpose of recovering re-usable and recyclable materials and disposing non-recyclable materials.

K. Permitted Waste Hauler: A company that holds a valid permit to collect and transport solid wastes from individuals or businesses for the purpose of recycling or disposal.

L. Recycling: The process of sorting, cleansing, treating, and reconstituting materials for the purpose of using the altered form in the manufacture of a new product. Recycling does not include burning, incinerating or thermally destroying solid waste.

1. On-site Recycling – Materials that are sorted and processed on site for use in an altered state in the work, i.e. concrete crushed for use as a sub-base in paving.
2. Off-site Recycling – Materials hauled to a location and used in an altered form in the manufacture of new products.

M. Recycling Facility: An operation that can legally accept materials for the purpose of processing the materials into an altered form for the manufacture of new products. Depending on the types of materials accepted and operating procedures, a recycling facility may or may not be required to have a solid waste facilities permit or be regulated by the local enforcement agency.

N. Reuse: Materials that are recovered for use in the same form, on-site or off-site.

O. Return: To give back reusable items or unused products to vendors for credit.

P. Salvage: To remove waste materials from the site for resale or re-use by a third party.

Q. Source-Separated Materials: Materials that are sorted by type at the site for the purpose of reuse and recycling.

R. Solid Waste: Materials that have been designated as non-recyclable and are discarded for the purposes of disposal.

S. Transfer Station: A facility that can legally accept solid waste for the purpose of temporarily storing the materials for re-loading onto other trucks and transporting them to a landfill for disposal, or recovering some materials for re-use or recycling.

**1.5 SUBMITTALS**

A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES, furnish the following:

B. Prepare and submit to the Resident Engineer a written demolition debris management plan. The plan shall include, but not be limited to, the following information:

1. Procedures to be used for debris management.
2. Techniques to be used to minimize waste generation.
3. Analysis of the estimated job site waste to be generated:
   a. List of each material and quantity to be salvaged, reused, recycled.
   b. List of each material and quantity proposed to be taken to a landfill.

4. Detailed description of the Means/Methods to be used for material handling.
   a. On site: Material separation, storage, protection where applicable.
   b. Off site: Transportation means and destination. Include list of materials.
      1) Description of materials to be site-separated and self-hauled to designated facilities.
      2) Description of mixed materials to be collected by designated waste haulers and removed from the site.
   c. The names and locations of mixed debris reuse and recycling facilities or sites.
   d. The names and locations of trash disposal landfill facilities or sites.
   e. Documentation that the facilities or sites are approved to receive the materials.

C. Designated Manager responsible for instructing personnel, supervising, documenting and administer over meetings relevant to the Waste Management Plan.

D. Monthly summary of construction and demolition debris diversion and disposal, quantifying all materials generated at the work site and disposed of or diverted from disposal through recycling.

**1.6 APPLICABLE PUBLICATIONS**

A Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. In the event that criteria requirements conflict, the most stringent requirements shall be met.

B. U.S. Green Building Council (USGBC):
LEED Green Building Rating System for New Construction

**1.7 RECORDS**

Maintain records to document the quantity of waste generated; the quantity of waste diverted through sale, reuse, or recycling; and the quantity of waste disposed by landfill or incineration. Records shall be kept in accordance with the LEED Reference Guide and LEED Template.

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

A. List of each material and quantity to be salvaged, recycled, reused.

B. List of each material and quantity proposed to be taken to a landfill.

C. Material tracking data: Receiving parties, dates removed, transportation costs, weight tickets, tipping fees, manifests, invoices, net total costs or savings.

**PART 3 - EXECUTION**

**3.1 COLLECTION**

A. Provide all necessary containers, bins and storage areas to facilitate effective waste management.

B. Clearly identify containers, bins and storage areas so that recyclable materials are separated from trash and can be transported to respective recycling facility for processing.

C. Hazardous wastes shall be separated, stored, disposed of according to local, state, federal regulations.

**3.2 DISPOSAL**

A. Contractor shall be responsible for transporting and disposing of materials that cannot be delivered to a source-separated or mixed materials recycling facility to a transfer station or disposal facility that can accept the materials in accordance with state and federal regulations.

B. Construction or demolition materials with no practical reuse or that cannot be salvaged or recycled shall be disposed of at a landfill or incinerator.

**3.3 REPORT**

A. With each application for progress payment, submit a summary of construction and demolition debris diversion and disposal including beginning and ending dates of period covered.

B. Quantify all materials diverted from landfill disposal through salvage or recycling during the period with the receiving parties, dates removed, transportation costs, weight tickets, manifests, invoices. Include the net total costs or savings for each salvaged or recycled material.

C. Quantify all materials disposed of during the period with the receiving parties, dates removed, transportation costs, weight tickets, tipping fees, manifests, invoices. Include the net total costs for each disposal.

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# SECTION 26 05 11
# REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

## PART 1 - GENERAL

### 1.1 DESCRIPTION

A. This Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, applies to all sections of Division 26.

B. Furnish and install electrical wiring, systems, equipment and accessories in accordance with the specifications and drawings.

### 1.2 MINIMUM REQUIREMENTS

A. References to the National Electrical Code (NEC), Underwriters Laboratories, Inc. (UL) and National Fire Protection Association (NFPA) are minimum installation requirement standards.

B. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the above standards.

### 1.3 TEST STANDARDS

A. All materials and equipment shall be listed, labeled or certified by a nationally recognized testing laboratory to meet Underwriters Laboratories, Inc., standards where test standards have been established. Equipment and materials which are not covered by UL Standards will be accepted provided equipment and material is listed, labeled, certified or otherwise determined to meet safety requirements of a nationally recognized testing laboratory. Equipment of a class which no nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe, will be considered if inspected or tested in accordance with national industrial standards, such as NEMA, or ANSI. Evidence of compliance shall include certified test reports and definitive shop drawings.

B. Definitions:

1. Listed; equipment or device of a kind mentioned which:
   a. Is published by a nationally recognized laboratory which makes periodic inspection of production of such equipment.
   b. States that such equipment meets nationally recognized standards or has been tested and found safe for use in a specified manner.
2. Labeled; equipment or device is when:
   a. It embodies a valid label, symbol, or other identifying mark of a nationally recognized testing laboratory such as Underwriters Laboratories, Inc.

b. The laboratory makes periodic inspections of the production of such equipment.
c. The labeling indicates compliance with nationally recognized standards or tests to determine safe use in a specified manner.

3. Certified; equipment or product is which:
a. Has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards or to be safe for use in a specified manner.
b. Production of equipment or product is periodically inspected by a nationally recognized testing laboratory.
c. Bears a label, tag, or other record of certification.

4. Nationally recognized testing laboratory; laboratory which is approved, in accordance with OSHA regulations, by the Secretary of Labor.

**1.4 QUALIFICATIONS (PRODUCTS AND SERVICES)**

A. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.

B. Product Qualification:
1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
2. The Government reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.

**1.5 MANUFACTURED PRODUCTS**

A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts shall be available.

B. When more than one unit of the same class of equipment is required, such units shall be the product of a single manufacturer.

C. Equipment Assemblies and Components:
1. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
2. Components shall be compatible with each other and with the total assembly for the intended service.
3. Constituent parts which are similar shall be the product of a single manufacturer.

**1.6 EQUIPMENT PROTECTION**

A. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain:
   1. During installation, enclosures, equipment, controls, controllers, circuit protective devices, and other like items, shall be protected against entry of foreign matter; and be vacuum cleaned both inside and outside before testing and operating and repainting if required.
   2. Damaged equipment shall be, as determined by the COR, placed in first class operating condition or be returned to the source of supply for repair or replacement.
   3. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
   4. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

**1.7 WORK PERFORMANCE**

A. All electrical work must comply with the requirements of NFPA 70 (NEC), NFPA 70B, NFPA 70E, OSHA Part 1910 subpart J, OSHA Part 1910 subpart S and OSHA Part 1910 subpart K in addition to other references required by contract.

B. Job site safety and worker safety is the responsibility of the contractor.

C. Electrical work shall be accomplished with all affected circuits or equipment de-energized. When an electrical outage cannot be accomplished in this manner for the required work, the following requirements are mandatory:
   1. Electricians must use full protective equipment (i.e., certified and tested insulating material to cover exposed energized electrical components, certified and tested insulated tools, etc.) while working on energized systems in accordance with NFPA 70E.
   2. Electricians must wear personal protective equipment while working on energized systems in accordance with NFPA 70E.
   3. Before initiating any work, a job specific work plan must be developed by the contractor with a peer review conducted and documented by the COR. The work plan must include procedures to be used on and near the live electrical equipment, barriers to be installed, safety equipment to be used and exit pathways.

D. For work on existing equipment, arrange, phase and perform work to assure electrical service for other buildings at all times. Refer to

Article OPERATIONS AND STORAGE AREAS under Section 01 00 00, GENERAL REQUIREMENTS.

E. New work shall be installed and connected to existing work neatly and carefully. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by Section 01 00 00, GENERAL REQUIREMENTS.

F. Coordinate location of equipment and conduit with other trades to minimize interferences. See Section 00 72 00, GENERAL CONDITIONS.

**1.8 EQUIPMENT INSTALLATION AND REQUIREMENTS**

A. Equipment location shall be as close as practical to locations shown on the drawings.

B. Working spaces shall not be less than specified in the NEC for all voltages specified.

C. Inaccessible Equipment:

1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.
2. "Conveniently accessible" is defined as being capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles.

**1.9 EQUIPMENT IDENTIFICATION**

A. In addition to the requirements of the NEC, install an identification sign which clearly indicates information required for use and maintenance of items.

B. Nameplates shall be laminated black phenolic resin with a white core with engraved lettering, a minimum of 6 mm (1/4 inch) high. Secure nameplates with screws. Nameplates that are furnished by manufacturer as a standard catalog item, or where other method of identification is herein specified, are exceptions.

**1.10 SUBMITTALS**

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. The Government's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site.

C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Government to ascertain that the proposed equipment and materials comply with

specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.

D. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
   1. Mark the submittals, "SUBMITTED UNDER SECTION_____".
   2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
   3. Submit each section separately.

E. The submittals shall include the following:
   1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.

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# SECTION 26 05 21
# LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW)

## PART 1 - GENERAL

### 1.1 DESCRIPTION

A. This section specifies the furnishing, installation, and connection of the low voltage power and lighting wiring.

### 1.2 SUBMITTALS

A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:

1. Manufacturer's Literature and Data: Showing each cable type and rating.
2. Certificates: Two weeks prior to final inspection, deliver to the COR four copies of the certification that the material is in accordance with the drawings and specifications and has been properly installed.

### 1.3 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are reference in the text by the basic designation only.

B. American Society of Testing Material (ASTM):

D2301-04.....Standard Specification for Vinyl Chloride Plastic Pressure Sensitive Electrical Insulating Tape

C. Federal Specifications (Fed. Spec.):

A-A-59544-00.....Cable and Wire, Electrical (Power, Fixed Installation)

C. National Fire Protection Association (NFPA):

70-08.....National Electrical Code (NEC)

D. Underwriters Laboratories, Inc. (UL):

44-02.....Thermoset-Insulated Wires and Cables
83-03.....Thermoplastic-Insulated Wires and Cables
467-01.....Electrical Grounding and Bonding Equipment
486A-01.....Wire Connectors and Soldering Lugs for Use with Copper Conductors
486C-02.....Splicing Wire Connectors
486D-02.....Insulated Wire Connector Systems for Underground Use or in Damp or Wet Locations
486E-00.....Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors

493-01.....Thermoplastic-Insulated Underground Feeder and Branch Circuit Cable
514B-02.....Fittings for Cable and Conduit
1479-03.....Fire Tests of Through-Penetration Fire Stops

**PART 2 - PRODUCTS**

**2.1 CABLE AND WIRE (POWER AND LIGHTING)**

A. Cable and Wire shall be in accordance with Fed. Spec. A-A-59544, except as hereinafter specified.

B. Single Conductor:
   1. Shall be annealed copper.
   2. Shall be stranded for sizes No. 8 AWG and larger, solid for sizes No. 10 AWG and smaller.
   3. Shall be minimum size No. 12 AWG.

C. Insulation:
   1. THW, XHHW, or dual rated THHN-THWN shall be in accordance with UL 44, and 83.
   2. Direct burial: Type MC (XHHW-2) galvanized steel interlocked armor with PVC jacket and shall be in accordance with UL 1596.

D. Color Code:
   1. Secondary service, feeder and branch circuit conductors shall be color coded as follows:

| 120/208 volt, 1 phase | Phase | 480/277 volt, 3 phase |
|---|---|---|
| Black | A | Brown |
| Red | B | Orange |
| | C | Yellow |
| White | Neutral | Gray * |
| * or white with colored (other than green) tracer. | | |

   2. Phase conductors No. 8 AWG and larger shall be color-coded using one of the following methods:
      a. Solid color compound or solid color coating.
      b. Stripes, bands, or hash marks of color specified above.
      c. Color as specified using 19 mm (3/4 inch) wide tape. Apply tape in half overlapping turns for a minimum of 75 mm (3 inches) for terminal points, and in junction boxes, pull boxes, troughs, and handholes. Apply the last two laps of tape with no tension to prevent possible unwinding. Where cable markings are covered by tape, apply tags to cable stating size and insulation type.

**2.2 SPLICES AND JOINTS**

A. In accordance with UL 486A, C, D, E and NEC.

B. Branch circuits (No. 10 AWG and smaller):

1. Connectors: Solderless, screw-on, reusable pressure cable type, 600 volt, 105 degree C with integral insulation, approved for copper and aluminum conductors.
2. The integral insulator shall have a skirt to completely cover the stripped wires.
3. The number, size, and combination of conductors, as listed on the manufacturers packaging shall be strictly complied with.

C. Feeder Circuits:

1. Connectors shall be indent, hex screw, or bolt clamp-type of high conductivity and corrosion-resistant material.
2. Field installed compression connectors for cable sizes 250 kcmil and larger shall have not less than two clamping elements or compression indents per wire.
3. Insulate splices and joints with materials approved for the particular use, location, voltage, and temperature. Insulate with not less than that of the conductor level that is being joined.
4. Plastic electrical insulating tape: ASTM D2304 shall apply, flame retardant, cold and weather resistant.

**2.3 WIRE LUBRICATING COMPOUND**

A. Suitable for the wire insulation and conduit it is used with, and shall not harden or become adhesive.

B. Shall not be used on wire for isolated type electrical power systems.

**PART 3 - EXECUTION**

**3.1 INSTALLATION, GENERAL**

A. Install in accordance with the NEC, and as specified.

B. Install all wiring in raceway systems, except where direct burial.

C. Splice cables and wires only in outlet boxes, junction boxes, pull boxes, or handholes.

D. For panelboards, cabinets, wireways, switches, and equipment assemblies, neatly form, train, and tie the cables in individual circuits.

E. Seal cable and wire entering a building from underground, between the wire and conduit where the cable exits the conduit, with a non-hardening approved compound.

F. Wire Pulling:

1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling of cables.
2. Use ropes made of nonmetallic material for pulling feeders.
3. Attach pulling lines for feeders by means of either woven basket grips or pulling eyes attached directly to the conductors, as approved by the COR.
4. Pull in multiple cables together in a single conduit.

G. The wires shall be derated in accordance with NEC Article 310. Neutral wires, under conditions defined by the NEC, shall be considered current-carrying conductors.

**3.2 SPLICE INSTALLATION**

A. Splices and terminations shall be mechanically and electrically secure.
B. Where the Government determines that unsatisfactory splices or terminations have been installed, remove the devices and install approved devices at no additional cost to the Government.

**3.3 DIRECT BURIAL CABLE INSTALLATION**

A. Tops of the cables:
   1. Below the finished grade: Minimum 600 mm (24 inches) unless greater depth is shown.
C. Work with extreme care near existing ducts, conduits, cables and other utilities to prevent any damage.
D. Trenches:
   1. Place a 75 mm (3 inch) layer of sand in the trenches after the irrigation piping before installing the cables.
   3. Place a 75 mm (3 inch) layer of sand over the installed cable before the control wiring cable.
E. Install the cables in continuous lengths. Splices within cable runs will not be accepted.
F. Connections and terminations shall be submersible type designed for the cables being installed.

**3.4 FIELD TESTING**

A. Feeders and branch circuits shall have their insulation tested after installation and before connection to utilization devices such as fixtures, motors, or appliances.
B. Tests shall be performed by megger and conductors shall test free from short-circuits and grounds.
C. Test conductor phase-to-phase and phase-to-ground.
D. The Contractor shall furnish the instruments, materials, and labor for these tests.

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# SECTION 26 05 26
# GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 DESCRIPTION

A. This section specifies general grounding and bonding requirements of electrical equipment operations and to provide a low impedance path for possible ground fault currents.

B. “Grounding electrode system” refers to all electrodes required by NEC, as well as including made, supplementary, lightning protection system grounding electrodes.

C. The terms “connect” and “bond” are used interchangeably in this specification and have the same meaning.

### 1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.

B. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Low Voltage power and lighting wiring.

### 1.3 SUBMITTALS

A. Test Reports: Provide certified test reports of ground resistance.

B. Certifications: Two weeks prior to final inspection, submit four copies of the following to the COR:

1. Certification that the materials and installation is in accordance with the drawings and specifications.
2. Certification, by the Contractor, that the complete installation has been properly installed and tested.

### 1.4 APPLICABLE PUBLICATIONS

Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

A. American Society for Testing and Materials (ASTM):

B1-2001.....Standard Specification for Hard-Drawn Copper Wire

B8-2004.....Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

81-1983.....IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

C. National Fire Protection Association (NFPA):

70-2008.....National Electrical Code (NEC)

D. Underwriters Laboratories, Inc. (UL):

44-2005 .....Thermoset-Insulated Wires and Cables

83-2003 .....Thermoplastic-Insulated Wires and Cables

467-2004 .....Grounding and Bonding Equipment

486A-486B-2003 .....Wire Connectors

**PART 2 - PRODUCTS**

**2.1 GROUNDING AND BONDING CONDUCTORS**

A. Equipment grounding conductors shall be UL 83 insulated stranded copper, except that sizes 6 mm² (10 AWG) and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes 25 mm² (4 AWG) and larger shall be permitted to be identified per NEC.

B. Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes 6 mm² (10 AWG) and smaller shall be ASTM B1 solid bare copper wire.

C. Electrical System Grounding: Conductor sizes shall not be less than what is shown on the drawings and not less than required by the NEC, whichever is greater.

**2.2 GROUND RODS**

A. Copper clad steel, 19 mm (3/4 inch) diameter by 3000 mm (10 feet) long, conforming to UL 467.

B. Quantity of rods shall be as required to obtain the specified ground resistance.

**2.3 SPLICES AND TERMINATION COMPONENTS**

A. Components shall meet or exceed UL 467 and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).

**2.4 GROUND CONNECTIONS**

A. Below Grade: Exothermic-welded type connectors.

B. Above Grade:

1. Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lockwashers.

## PART 3 - EXECUTION

### 3.1 GENERAL

A. Ground in accordance with the NEC, as shown on drawings, and as hereinafter specified.

B. System Grounding:

1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.
2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.

C. Equipment Grounding: Metallic structures (including ductwork and building steel), enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be bonded and grounded.

### 3.2 INACCESSIBLE GROUNDING CONNECTIONS

A. Make grounding connections, which are buried or otherwise normally inaccessible (except connections for which periodic testing access is required) by exothermic weld.

### 3.3 SECONDARY EQUIPMENT AND CIRCUITS

A. Transformers:

1. Separately derived systems (mini-power zone secondary): Ground the secondary neutral at the transformer. Provide a grounding electrode conductor from the transformer to the nearest component of the grounding electrode system.

B. Conduit Systems:

1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
2. All conduit systems shall contain an equipment grounding conductor.

C. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders and branch circuits.

D. Boxes, Cabinets, Enclosures, and Panelboards:

1. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes.
2. Provide lugs in each box and enclosure for equipment grounding conductor termination.
3. Provide ground bars in panelboards, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.

E. Receptacles shall not be grounded through their mounting screws. Ground with a jumper from the receptacle green ground terminal to the device box ground screw and the branch circuit equipment grounding conductor.

**3.4 GROUND RESISTANCE**

A. Grounding system resistance to ground shall not exceed 5 ohms. Make necessary modifications or additions to the grounding electrode system for compliance without additional cost to the Government. Final tests shall assure that this requirement is met.

B. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

C. Below-grade connections shall be visually inspected by the COR prior to backfilling. The Contractor shall notify the COR 24 hours before the connections are ready for inspection.

**3.5 GROUND ROD INSTALLATION**

A. Drive each rod vertically in the earth, not less than 3000 mm (10 feet) in depth.

B. Where permanently concealed ground connections are required, make the connections by the exothermic process to form solid metal joints. Make accessible ground connections with mechanical pressure type ground connectors.

C. Where rock prevents the driving of vertical ground rods, install angled ground rods or grounding electrodes in horizontal trenches to achieve the specified resistance.

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# SECTION 26 05 33
# RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 DESCRIPTION

A. This section specifies the furnishing, installation, and connection of conduit, fittings, and boxes to form complete, coordinated, grounded raceway systems. Raceways are required for all wiring unless shown or specified otherwise.

B. Definitions: The term conduit, as used in this specification, shall mean any or all of the raceway types specified.

### 1.2 RELATED WORK

A. General electrical requirements and items that is common to more than one section of Division 26: Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

B. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

### 1.3 SUBMITTALS

In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:

A. Shop Drawings:

1. Size and location of handholes.

B. Certification: Prior to final inspection, deliver to the COR four copies of the certification that the material is in accordance with the drawings and specifications and has been properly installed.

### 1.4 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

B. National Fire Protection Association (NFPA):

70-08.....National Electrical Code (NEC)

C. Underwriters Laboratories, Inc. (UL):

1-05.....Flexible Metal Conduit
5-04.....Surface Metal Raceway and Fittings
6-07.....Rigid Metal Conduit
50-07.....Enclosures for Electrical Equipment
360-09.....Liquid-Tight Flexible Steel Conduit
467-07.....Grounding and Bonding Equipment

514A-04.....Metallic Outlet Boxes
514B-04.....Fittings for Cable and Conduit
514C-96.....Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
651-05.....Schedule 40 and 80 Rigid PVC Conduit
651A-00.....Type EB and A Rigid PVC Conduit and HDPE Conduit
797-07.....Electrical Metallic Tubing
1242-06.....Intermediate Metal Conduit

D. National Electrical Manufacturers Association (NEMA):
TC-3-04.....PVC Fittings for Use with Rigid PVC Conduit and Tubing
FB1-07.....Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

**PART 2 - PRODUCTS**

**2.1 MATERIAL**

A. Conduit Size: In accordance with the NEC, but not less than 13 mm (1/2 inch) unless otherwise shown.

B. Conduit:
1. Rigid galvanized steel: Shall Conform to UL 6, ANSI C80.1.
2. Rigid intermediate steel conduit (IMC): Shall Conform to UL 1242, ANSI C80.6.
3. Electrical metallic tubing (EMT): Shall Conform to UL 797, ANSI C80.3. Maximum size not to exceed 105 mm (4 inch.
4. Flexible galvanized steel conduit: Shall Conform to UL 1.
5. Liquid-tight flexible metal conduit: Shall Conform to UL 360.
6. Direct burial plastic conduit: Shall conform to UL 651 and UL 651A, heavy wall PVC.
7. Surface metal raceway: Shall Conform to UL 5.

C. Conduit Fittings:
1. Rigid steel and IMC conduit fittings:
a. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
b. Standard threaded couplings, locknuts, bushings, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
c. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
d. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into the metallic body of the fitting.

Bushings made entirely of metal or nonmetallic material are not permitted.

e. Sealing fittings: Threaded cast iron type. Use continuous drain type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.

2. Electrical metallic tubing fittings:
   a. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
   b. Only steel or malleable iron materials are acceptable.
   c. Couplings and connectors: Concrete tight and rain tight, with connectors having insulated throats. Use gland and ring compression type couplings and connectors for conduit sizes 50 mm (2 inches) and smaller. Use set screw type couplings with four set screws each for conduit sizes over 50 mm (2 inches). Use set screws of case-hardened steel with hex head and cup point to firmly seat in wall of conduit for positive grounding.
   d. Indent type conduit connectors or couplings are prohibited.
   e. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
3. Flexible steel conduit fittings:
   a. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
   b. Clamp type, with insulated throat.
4. Liquid-tight flexible metal conduit fittings:
   a. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
   b. Only steel or malleable iron materials are acceptable.
   c. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
5. Direct burial plastic conduit fittings:
   a. Fittings shall meet the requirements of UL 514C and NEMA TC3.
   b. As recommended by the conduit manufacturer.
6. Surface metal raceway fittings: As recommended by the raceway manufacturer.
7. Expansion and deflection couplings:
   a. Conform to UL 467 and UL 514B.

b. Accommodate, 19 mm (0.75 inch) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.
c. Include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents in accordance with UL 467, and the NEC code tables for ground conductors.
d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.

D. Conduit Supports:
1. Parts and hardware: Zinc-coat or provide equivalent corrosion protection.
2. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
3. Multiple conduit (trapeze) hangers: Not less than 38 mm by 38 mm (1 1/2 by 1 1/2 inch), 12 gage steel, cold formed, lipped channels; with not less than 9 mm (3/8 inch) diameter steel hanger rods.
4. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.

E. Outlet, Junction, and Pull Boxes:
1. UL-50 and UL-514A.
2. Cast metal where required by the NEC or shown, and equipped with rustproof boxes.
3. Sheet metal boxes: Galvanized steel, except where otherwise shown.

F. Wireways: Equip with hinged covers.

## PART 3 - EXECUTION

### 3.1 PENETRATIONS

A. Waterproofing: At exterior wall conduit penetrations, completely seal clearances around the conduit and make watertight.

### 3.2 INSTALLATION, GENERAL

A. In accordance with UL, NEC, as shown, and as hereinafter specified.
B. Install conduit as follows:
1. In complete runs before pulling in cables or wires.
2. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new undamaged material.
3. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
4. Cut square with a hacksaw, ream, remove burrs, and draw up tight.

5. Mechanically and electrically continuous.
6. Independently support conduit at 8’0” on center. Do not use other supports i.e., (suspended ceilings, suspended ceiling supporting members, lighting fixtures, conduits, mechanical piping, or mechanical ducts).
7. Support within 300 mm (1 foot) of changes of direction, and within 300 mm (1 foot) of each enclosure to which connected.
8. Secure conduits to cabinets, junction boxes, pull boxes and outlet boxes with bonding type locknuts. For rigid and IMC conduit installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make conduit connections to junction box covers.

C. Conduit Bends:
1. Make bends with standard conduit bending machines.
2. Conduit hickey may be used for slight offsets, and for straightening stubbed out conduits.
3. Bending of conduits with a pipe tee or vise is prohibited.

D. Layout and Homeruns:
1. Install conduit with wiring, including homeruns, as shown.
2. Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted approved by the COR.

**3.3 CONCEALED WORK INSTALLATION**

A. Above Suspended Ceilings:
1. Conduit for conductors 600 volts and below:
Rigid steel, IMC, or EMT. Different type conduits mixed indiscriminately in the same system is prohibited.
2. Align and run conduit parallel or perpendicular to the building lines.
3. Tightening set screws with pliers is prohibited.

**3.4 EXPOSED WORK INSTALLATION**

A. Conduit for Conductors 600 volts and below:
1. Rigid steel, IMC, or EMT. Different type of conduits mixed indiscriminately in the system is prohibited.

B. Align and run conduit parallel or perpendicular to the building lines.

C. Install horizontal runs close to the ceiling or beams and secure with conduit straps.

D. Support horizontal or vertical runs at not over 2400 mm (eight foot) intervals.

E. Surface metal raceways: Use only where shown.

**3.5 DIRECT BURIAL INSTALLATION**

A. Exterior routing (600 Volt and Less, and 1500 mm (5 feet) from the buildings):
   1. Conduit: Thick wall Schedule 40 PVC.
   2. Mark conduit at uniform intervals to show the kind of material, direct burial type, and the UL approval label.
   3. Install conduit fittings and terminations as recommended by the conduit manufacturer.
   4. Tops of conduits shall be as follows unless otherwise shown:
      a. Not less than 600 mm (24 inches) below finished grade.
   5. Work with extreme care near existing ducts, conduits, cables, and other utilities to avoid damaging them.
   6. Seal conduits at building entrances and at outdoor terminations for equipment with a suitable compound that prevents the entrance of moisture and gases.
   7. Where metal conduit is shown, install threaded heavy wall rigid steel galvanized conduit or type A20 rigid steel galvanized conduit coated with .5 mm (20 mil) bonded PVC, or rigid steel or IMC, PVC coated or standard coated with bituminous asphaltic compound.

**3.6 WET OR DAMP LOCATIONS**

A. Unless otherwise shown, use conduits of rigid steel or IMC.

**3.7 MOTORS AND VIBRATING EQUIPMENT**

A. Use flexible metal conduit for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission.
B. Provide liquid-tight flexible metal conduit for installation in exterior locations. Provide a green ground wire with flexible metal conduit.

**3.8 CONDUIT SUPPORTS, INSTALLATION**

A. Safe working load shall not exceed 1/4 of proof test load of fastening devices.
B. Use pipe straps or individual conduit hangers for supporting individual conduits. Maximum distance between supports is 2.5 m (8 foot) on center.
C. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and 90 kg (200 pounds). Attach each conduit with U-bolts or other approved fasteners.
D. Support conduit independently of junction boxes, pull boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.
E. Hollow Masonry: Toggle bolts are permitted.
F. Bolts supported only by plaster or gypsum wallboard are not acceptable.

G. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.

H. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.

I. Chain, wire, or perforated strap shall not be used to support or fasten conduit.

J. Spring steel type supports or fasteners are prohibited for all uses except: Horizontal and vertical supports/fasteners within walls.

**3.9 BOX INSTALLATION**

A. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling in operations.

B. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.

C. Minimum size of outlet boxes for ground fault interrupter (GFI) receptacles is 100 mm (4 inches) square by 55 mm (2 1/8 inches) deep, with device covers for the wall material and thickness involved.

D. On all Branch Circuit junction box covers, identify the circuits with black marker.

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# SECTION 26 05 41
# UNDERGROUND ELECTRICAL CONSTRUCTION

## PART 1 - GENERAL

### 1.1 DESCRIPTION

A. This section specifies the furnishing, installation and connection of handholes and ducts to form a complete underground raceway system.

B. “Duct” and “conduit”, and “rigid metal conduit” and “rigid steel conduit are used interchangeably in this specification and have the same meaning.

### 1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.

B. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits, fittings and boxes for raceway systems.

C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

### 1.3 SUBMITTALS

A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

B. Shop Drawings:

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
2. Include handholes, duct materials, and hardware. Proposed deviations from details on the drawings shall be clearly marked on the submittals.

C. Certifications: Two weeks prior to final inspection, submit four copies of the following to the COR:

1. Certification that the materials are in accordance with the drawings and specifications.
2. Certification, by the Contractor, that the complete installation has been properly installed and tested.

### 1.4 APPLICABLE PUBLICATIONS

Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

A. American Concrete Institute (ACI):
Building Code Requirements for Structural Concrete
318/318M-2005.....Building Code Requirements for Structural Concrete & Commentary
SP-66-04.....ACI Detailing Manual

B. American Society for Testing and Materials (ASTM):
C478/C478M 2009(b).....Standard Specification for Precast Reinforced Concrete Manhole Sections
C990 REV A 2008 .....Standard Specification for joints concrete pipe, Manholes and Precast Box using performed flexible Joint sealants.

C. Institute of Electrical and Electronic Engineers (IEEE):
C2-2002 .....National Electrical Safety Code

D. National Electrical Manufacturers Association (NEMA):
RNI 2005.....Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
TC 2 2003.....Electrical Polyvinyl Chloride (PVC) Tubing And Conduit
TC 3-2004.....PVC Fittings for Use With Rigid PVC Conduit And Tubing
TC 6 & 8 2003.....PVC Plastic Utilities Duct For Underground Installations
TC 9-2004.....Fittings For PVC Plastic Utilities Duct For Underground Installation

E. National Fire Protection Association (NFPA):
70 2008.....National Electrical Code (NEC)

F. Underwriters Laboratories, Inc. (UL):
6-2007.....Electrical Rigid Metal Conduit-Steel
467-2007.....Standard for Grounding and Bonding Equipment
651-2005.....Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings
651A-2000.....Type EB and A Rigid PVC Conduit and HDPE Conduit, (RTRC)
651B-2007.....Continuous Length HDPE Conduit

G. U.S. General Services Administration (GSA):
SS-S-210A-1981.....Sealing Compound, Preformed Plastic for Expansion joints And Pipe Joints

**PART 2 - PRODUCTS**

**2.1 HANDHOLES**

A. Shall be matched die molded of fiberglass or polymer concrete composite with approximate dimensions as indicated on the drawings or required by code. When buried, the unit shall be capable of supporting an ultimate downward load of 2955 kg (6500 pounds) distributed over a 150 by 150 mm (6 by 6 inch) area imposed anywhere on the cover surface. A matching weatherproof cover with nonskid surface shall be provided for each handhole. Cover to be engraved “ELECTRIC.”

**2.2 DUCTS**

A. Ducts (direct burial):
   1. Plastic duct:
      a. NEMA TC2 and TC3
      b. UL 651, 651A and 651B, Schedule 40 PVC.
      c. Duct shall be suitable for use with 75 degree C rated conductors.
   2. Ducts shall interface with the sleeves used for the direct bored locations.

**2.3 WARNING TAPE:**

A. Standard 4-mil polyethylene 76 mm (3 inch) wide tape, non-detectable type, red with black letters, imprinted with “CAUTION BURIED ELECTRIC CABLE BELOW”.

**2.4 PULL ROPE:**

A. Plastic with 890N (200 pound) minimum tensile strength.

**PART 3 - EXECUTION**

**3.1 HANDHOLE CONSTRUCTION AND INSTALLATION**

A. General Requirements:
   1. Locate handholes at the approximate locations shown on the drawings with due consideration given to the location of other utilities, grades, and paving.
   2. Handholes shall be provided at each end of the direct bore to allow transition from flexible metal cable to wire in conduit.
   3. Handholes shall be provided along flexible metal cable run as required to facilitate the cable installation or cable lengths.

B. Access for Handholes: Make the top of frames and covers flush with finished grade.

**3.2 DUCT INSTALLATION**

A. General Requirements:

1. Ducts shall be in accordance with the NEC, IEEE C2, and as specified.
2. Slope ducts to drain towards handholes, and away from building and equipment entrances. Pitch not less than 100 mm (4 inches) in 30 M (100 feet).
3. Underground conduit stub-ups and sweeps to equipment inside of buildings shall be PVC-coated galvanized rigid steel, and shall extend a minimum of 1500 mm (5 feet) outside of building foundation.
4. Stub-ups, sweeps, and risers to equipment mounted on outdoor concrete slabs shall be PVC-coated galvanized rigid steel, and shall extend a minimum of 1500 mm (5 feet) away from edge of slab.
5. Install insulated grounding bushings on the terminations.
6. Clearances between individual ducts:
   a. For power and signal services, not less than 150 mm (6 inches).
   b. Provide plastic spacers to maintain clearances.
7. Duct lines shall terminate as shown on the drawings. All ducts shall be fitted with end bells.
8. Couple the ducts with proper couplings.
9. Keep ducts clean of earth, sand, or gravel during construction, and seal with tapered plugs upon completion of each portion of the work.

B. Direct Burial Duct and Conduits:

1. Tops of ducts and conduits shall be:
   a. Not less than 600 mm (24 inches).

C. Duct and Conduit Cleaning:

1. Upon completion of the duct bank installation or installation of direct buried ducts, a standard flexible mandrel shall be pulled through each duct to loosen particles of earth, sand, or foreign material left in the line. The mandrel shall be not less than 3600 mm (12 inches) long, and shall have a diameter not less than 13 mm (1/2 inch) less than the inside diameter of the duct. A brush with stiff bristles shall then be pulled through each duct to remove the loosened particles. The diameter of the brush shall be the same as, or slightly larger than the diameter of the duct.
2. Mandrel pulls shall be witnessed by the COR.

D. Duct and Conduit Sealing: Seal the ducts and conduits at building entrances, and at outdoor terminations for equipment, with a suitable non-hardening compound to prevent the entrance of moisture and gases.

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# SECTION 26 22 00
# LOW-VOLTAGE TRANSFORMERS

## PART 1 – GENERAL

### 1.1 DESCRIPTION

A. This section specifies the furnishing, installation and connection of the dry type general-purpose transformers.

### 1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.

B. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits and outlet boxes.

C. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.

D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

### 1.3 SUBMITTALS

A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:

B. Shop Drawings:

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
2. Include electrical ratings, impedance, dimensions, weight, mounting details, decibel rating, terminations, temperature rise, no load and full load losses, and connection diagrams.
3. Complete nameplate data including manufacturer’s name and catalog number.

C. Manuals:

1. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals including technical data sheets and wiring diagrams.
2. If changes have been made to the originally submitted maintenance and operating manuals, then two weeks prior to final inspection submit four copies of updated maintenance and operating manuals to the COR.

D. Certifications: Two weeks prior to the final inspection, submit four copies of the following to the COR:

1. Certification by the manufacturer that the transformers conform to the requirements of the drawings and specifications.

2. Certification that the equipment has been properly installed and tested.

**1.4 APPLICABLE PUBLICATIONS**

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. National Fire Protection Association (NFPA):
70-08.....National Electrical Code (NEC)

C. National Electrical Manufacturers Association (NEMA):
ST 20-97.....Dry-Type Transformers for General Applications

**PART 2 - PRODUCTS**

**2.1 GENERAL PURPOSE DRY TYPE TRANSFORMERS**

A. Unless otherwise specified, dry type transformers shall be in accordance with NEMA, NEC and as shown on the drawings. Transformers shall be UL listed or labeled.

B. Dry type transformers shall have the following features:
1. Self-cooled by natural convection, isolating windings, dry type. Autotransformers will not be accepted.
2. Rating and winding connections shall be as shown on the drawings.
3. Transformers shall have copper windings.
4. Ratings shown on the drawings are for continuous-duty without the use of cooling fans.
5. Insulation systems:
a. Transformers 30 KVA and larger: UL rated 220 degrees C system having an average maximum rise by resistance of 150 degrees C in a maximum ambient of 40 degrees C.
b. Transformers below 30 KVA: Same as for 30 KVA and larger or UL rated 185 degrees C system having an average maximum rise by resistance of 115 degrees C in a maximum ambient of 40 degrees C.
6. Core and coil assemblies:
a. Rigidly braced to withstand the stresses caused by short circuit currents and rough handling during shipment.
b. Cores shall be grain oriented, non-aging, and silicon steel.
c. Coils shall be continuous windings without splices except for taps.
d. Coil loss and core loss shall be minimum for efficient operation.
e. Primary and secondary tap connections shall be brazed or pressure type.
f. Coil windings shall have end fillers or tie downs for maximum strength.

7. Nominal impedance shall be as permitted by NEMA.
8. Single phase transformers rated 15 KVA through 25 KVA shall have two, 5 percent full capacity taps below normal rated primary voltage. All transformers rated 30 KVA and larger shall have two, 2-1/2 percent full capacity taps above, and four, 2-1/2 percent full capacity taps below normal rated primary voltage.
9. Core assemblies shall be grounded to their enclosures by adequate flexible ground straps.
10. Enclosures:
    a. Not less than code gage steel.
    b. Outdoor enclosures shall be NEMA 3R.
    c. Temperature rise at hottest spot shall conform to NEMA Standards, and shall not bake and peel off the enclosure paint after the transformer has been placed in service.
    d. Ventilation openings shall prevent accidental access to live components.
    e. Thoroughly clean and paint enclosure at the factory with manufacturer's prime coat and standard finish.
11. Standard NEMA features and accessories including ground pad, lifting provisions and nameplate with the wiring diagram and sound level indicated on it.
12. Dimensions and configurations shall conform to the spaces designated for their installations.
13. Transformers shall meet the minimum energy efficiency values per NEMA TP1.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Installation of transformers shall be in accordance with the NEC, as recommended by the equipment manufacturer and as shown on the drawings.
B. Install the transformers with adequate clearance at a minimum of 100 mm (4 inches) from wall and adjacent equipment for air circulation to remove the heat produced by transformers.
C. Install transformers on vibration pads designed to suppress transformer noise and vibrations.
D. Use flexible metal conduit to enclose the conductors from the transformer to the raceway systems.
E. Transformer provided as part of mini-power zone unit shall comply with these specifications.

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# SECTION 26 24 16
# PANELBOARD

## PART 1 - GENERAL

### 1.1 DESCRIPTION

This section specifies the furnishing, installation and connection of panelboards.

### 1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one Section of Division 26.

B. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits and outlet boxes.

C. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.

D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

### 1.3 SUBMITTALS

A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

B. Shop Drawings:

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
2. Include electrical ratings, dimensions, mounting details, materials, wiring diagrams accessories and weights of equipment. Complete nameplate data including manufacturer’s name and catalog number.

C. Certification: Two weeks prior to final inspection, submit four copies of the following to the COR:

1. Certification that the material is in accordance with the drawings and specifications has been properly installed, and that the loads are balanced.

### 1.4 APPLICABLE PUBLICATIONS

Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

A. National Electrical Manufacturers Association (NEMA):

PB-1-2006.....Panelboards

AB-1-2002.....Molded Case Circuit Breakers, Molded Case Switches and Circuit Breaker Enclosures

B. National Fire Protection Association (NFPA):

70-2005 .....National Electrical Code (NEC)

70E-2009.....Standard for Electrical Life Safety in the Workplace

C. Underwriters Laboratories, Inc. (UL):

50-2007.....Enclosures for Electrical Equipment

67-2009.....Panel boards

489-2009.....Molded Case Circuit Breakers and Circuit Breaker Enclosures

**PART 2 - PRODUCTS**

**2.1 PANELBOARDS**

A. Panelboards shall be in accordance with UL, NEMA, NEC, and as shown on the drawings.

B. Panelboards shall be standard manufactured products. All components of the panelboards shall be the product and assembly of the same manufacturer. All similar units of all panelboards to be of the same manufacturer.

C. Panelboards shall be completely factory assembled with molded case circuit breakers.

D. Panelboards shall have ratings as indicated on the drawings.

E. Panelboards shall conform to NEMA PB-1, NEMA AB-1 and UL 67 and have the following features:

1. Nonreduced size copper bus bars.
2. Bus bar connections to the branch circuit breakers shall be the “distributed phase” or “phase sequence” type. Single-phase, three-wire panelboard busing shall be such that when any two adjacent single-pole breakers are connected to opposite phases; two-pole breakers can be installed in any location.
3. Mechanical lugs furnished with panelboards shall be cast, stamped or machined metal alloys of sizes suitable for the conductors indicated to be connected thereto.
4. Neutral bus shall be 100% rated, mounted on insulated supports.
5. Grounding bus bar equipped with screws or lugs for the connection of grounding wires.
6. Buses braced for the available short circuit current.

7. Protective devices shall be designed so that they can be easily replaced.
8. Where designated on panel schedule "spaces", include all necessary bussing, device support and connections. Provide blank cover for each space.
9. Series rated panelboards are not permitted.

**2.2 CABINETS AND TRIMS**

A. Cabinets:
1. Provide galvanized steel cabinets to house panelboards. Cabinets for outdoor panels shall be factory primed and suitably treated with a corrosion-resisting paint finish meeting UL 50 and UL 67.
2. Cabinet enclosure shall not have ventilating openings.
3. Cabinets for panelboards may be of one-piece formed steel or of formed sheet steel with end and side panels welded, riveted, or bolted as required.

**2.3 MOLDED CASE CIRCUIT BREAKERS FOR PANELBOARDS**

A. Breakers shall be UL 489 listed and labeled, in accordance with the NEC, as shown on the drawings, and as specified.
B. Circuit breakers in panelboards shall be plug-on type on phase bus bar or branch circuit bar.
1. Molded case circuit breakers for lighting and appliance branch circuit panelboards shall have minimum interrupting rating as indicated on the drawings.
2. Molded case circuit breakers shall have automatic, trip free, non-adjustable, inverse time, and instantaneous magnetic trips for 100-ampere frame or less.
C. Breaker features shall be as follows:
1. A rugged, integral housing of molded insulating material.
2. Silver alloy contacts.
3. Arc quenchers and phase barriers for each pole.
4. Quick-make, quick-break, operating mechanisms.
5. A trip element for each pole, thermal magnetic type with long time delay and instantaneous characteristics, a common trip bar for all poles and a single operator.
6. Electrically and mechanically trip free.
7. An operating handle which indicates ON, TRIPPED, and OFF positions.

8. An overload on one pole of a multipole breaker shall automatically cause all the poles of the breaker to open.
9. For circuit breakers being added to existing panelboards, coordinate the breaker type with existing panelboards. Modify the panel directory in a neat and typewritten manner.

**2.3 MINI-POWER ZONE PANELBOARD**

A. Mini-power Zone panelboard shall comply with requirements of Part 2.1 and 2.2 and include an integral transformer per Section 26 22 00, LOW-VOLTAGE TRANSFORMERS.

B. Entire assembly shall be contained within a NEMA 3R enclosure.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

A. Installation shall be in accordance with the Manufacturer’s instructions, the NEC, as shown on the drawings, and as specified.

B. Install a typewritten schedule of circuits in each panelboard after being submitted to and approved by the COR.

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# SECTION 26 27 26
# WIRING DEVICES

## PART 1 - GENERAL

### 1.1 DESCRIPTION

A. This section specifies the furnishing, installation and connection of wiring devices.

### 1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section of Division 26.

B. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits and outlets boxes.

C. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.

D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.

### 1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

### 1.4 SUBMITTALS

A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:

B. Certifications: Two weeks prior to final inspection, submit four copies of the following to the COR: Certification by the Contractor that the devices comply with the drawings and specifications, and have been properly installed, aligned, and tested.

### 1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.

B. National Fire Protection Association (NFPA):
70-08.....National Electrical Code (NEC)

C. National Electrical Manufacturers Association (NEMA):
WD 1-99.....General Color Requirements for Wiring Devices
WD 6-02 .....Wiring Devices – Dimensional Requirements

D. Underwriter’s Laboratories, Inc. (UL):
231-08.....Power Outlets

467-07.....Grounding and Bonding Equipment
943-08.....Ground-Fault Circuit-Interrupters

**PART 2 - PRODUCTS**

**2.1 RECEPTACLES**

A. General: All receptacles shall be listed by Underwriters Laboratories, Inc., and conform to NEMA WD 6.
   1. Mounting straps shall be plated steel, with break-off plaster ears and shall include a self-grounding feature. Terminal screws shall be brass, brass plated or a copper alloy metal.
   2. Receptacles shall have provisions for back wiring with separate metal clamp type terminals (four min.) and side wiring from four captively held binding screws.

B. Duplex Receptacles: Heavy duty, specification grade, single phase, 20 ampere, 120 volts, 2-pole, 3-wire, and conform to the NEMA 5-20R configuration in NEMA WD 6. The ungrounded pole of each receptacle shall be provided with a separate terminal.
   1. Bodies shall be ivory in color.
   2. Ground Fault Interrupter Duplex Receptacles: Shall be an integral unit, heavy duty, specification grade, suitable for mounting in a standard outlet box.
      a. Ground fault interrupter shall consist of a differential current transformer, solid state sensing circuitry and a circuit interrupter switch. Device shall have nominal sensitivity to ground leakage current of five milliamperes and shall function to interrupt the current supply for any value of ground leakage current above five milliamperes (+ or – 1 milliamp) on the load side of the device. Device shall have a minimum nominal tripping time of 1/30th of a second.

C. Weatherproof Receptacles: Shall consist of a duplex receptacle, mounted in box with a gasketed, weatherproof, cast metal cover plate and cap over each receptacle opening. The cap shall be permanently attached to the cover plate by a spring-hinged flap. The weatherproof integrity shall not be affected when heavy duty specification or cemetery grade attachment plug caps are inserted.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

A. Installation shall be in accordance with the NEC and as shown as on the drawings.

B. Ground terminal of each receptacle shall be bonded to the outlet box with an approved green bonding jumper, and also connected to the green equipment grounding conductor.

C. Test wiring devices for damaged conductors, high circuit resistance, poor connections, inadequate fault current path, defective devices, or similar problems using a portable receptacle tester. Correct circuit conditions, remove malfunctioning units and replace with new, and retest as specified above.

D. Test GFCI devices for tripping values specified in UL 1436 and UL 943.

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# SECTION 32 82 00
# IRRIGATION PUMP STATION

## PART 1 - GENERAL

### 1.1 SCOPE

A. Contractor is to provide a complete and working pumping station. Furnish all labor, materials, supplies, equipment, tools, and transportation, and perform all operations in connection with and reasonably incidental to the complete manufacturing and installation of the pump station, and guarantee/warranty as shown on the drawings, the installation details, and as specified herein. Items of work specifically included are:

1. Procurement of all applicable licenses, permits, and fees as required by local utilities and regulations.
2. Coordination of Utility Locates (“Call Before You Dig”).
3. Services of a factory field service person to supervise the assembly, installation, and start-up of the pumping system, and the training of maintenance staff.
4. Furnishing and installing a prefabricated skid mounted VFD controlled booster pump station including electrical controls and all other items as specified.
5. Maintenance period.

### 1.2 RELATED WORK

A. Division 26 Electrical

B. Section 32 84 00 PLANTING IRRIGATION

### 1.3 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American National Standard Institute (ANSI):

1. B16.5: Pipe Flanges and Flanged Fittings
2. B58.1: Turbine Pump

C. American Society for Testing and Materials (ASTM):

1. A48: Standard Specification for Gray Iron Castings
2. A53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
3. A105: Standard Specification for Carbon Steel Forging for Pipe Applications

4. A126: Standard Specification for Gray Ion Castings for Valves, Flanges, and Pipe Fittings
5. A234: Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

C. International Organization for Standardization (ISO):
1. 9001: Requirements for a Quality Management System

D. National Electrical Manufacturers Association (NEMA):
1. NEMA 4: Indoor or Outdoor Enclosures with Protection Against Wind Blown Dust and Rain, Splashing Water, Hose Directed Water, and Undamaged by the Formation of Ice on the Enclosure.
2. MG-1-12: Motors and Generators

E. Underwriters Laboratories Inc. (UL):
1. File #E142155: Industrial Control Panels

F. National Electric Code: (latest edition 2011)

G. Uniform Plumbing Code: (latest edition)

**1.4 DISCREPANCIES:** It is the intent of these plans and specification that the irrigation pump station be complete and workable. It is the Contractor's responsibility to make sure that the equipment furnished is compatible and adheres to all regulations. Any discrepancies should be noted immediately and should be reported to the Contracting Officer’s Technical Representative for clarification.

**1.5 BIDDER QUALIFICATIONS**

A. Contractor must have demonstrated, using persons directly employed by the Contractor, experience with the installation of at least five (5) pre-fabricated pumping systems having similar or larger flows.

B. Contractor must be licensed in the State of Illinois.

**1.6 SUBMITTALS**

A. Make submittal and provide number of copies per Specification Section 013323. Unless otherwise noted, provide four (4) copies of pumping system information in a 3-ring binder with table of contents and index sheet. Provide sections that are indexed and labeled for pipe, valves, fittings, pump and motor, control system components, shop drawings, and all other equipment shown or described on the drawings and within these specifications. Highlight items being supplied on the catalog cut sheets. Submittal package must be complete prior to being reviewed by the Contracting Officer’s Technical Representative. Incomplete submittals will be returned without review

B. Materials List: Include pipe, valve, fittings, pump and motor, control system components, and electrical equipment. Quantities of materials need not be included.

C. Manufacturers' Data: Submit manufacturers' catalog cuts, performance curves for pump, specifications, and operating instructions for equipment shown on the materials list. Submit complete instructions for installation, operation, and recommended maintenance of the pump station. Installation instructions must include pump station manufacturer’s recommended mounting and anchoring details.

D. Maintenance Manual: Submit Bound maintenance manual that includes all manufacturers’ data listed above and recommended operating procedures and preventive maintenance procedures. Include guide for troubleshooting operation problems with the pump station and complete documentation for programming, recommended settings and adjustments.

E. Shop Drawings:

1. Submit shop drawings of proposed pump station. Show products required for proper installation, their relative locations, and critical dimensions. Submit technical data sheets, electrical schematics, sequence of operation, UL listing authorization form. Note modifications to the installation drawings.
2. The construction documents show the representative layout, elevation view, and critical dimensions for the pump station and enclosure. Pump station manufacturer is responsible for layout and design of the pump station supplied, and any special coordination issues that affect the critical dimensions, layout, or orientation of the pump station. Installation shop drawing must include pump station manufacturer’s recommended mounting and anchoring details.

F. Factory Testing:

1. Pump station must be completely wired, piped, hydraulically, electrically and flow tested to full station capacity at factory prior to shipment to job site.
2. Submit a proof of testing report including name of test, date of test, name of the individual completing the test, name of the company completing the test and a summary of the test results. Document all tests were passed.
3. Testing report must be verified by Contracting Officer’s Technical Representative prior to pump control panel shipment.

G. Maintenance and Operation Instructions: Submit information listed in Part 3 of these specifications.

H. Record Drawings: Submit information listed in Part 3 of these specifications.

**1.7 RULES AND REGULATIONS**

A. Work and materials shall be in accordance with the latest edition of the National Electric Code, the Uniform Plumbing Code as published by the Western Plumbing Officials Association, and applicable laws and regulations of the governing authorities.

B. When the contract documents call for materials or construction of a better quality or larger size than required by the above-mentioned rules and regulations, provide the quality and size required by the contract documents.

C. All electrical control panels with controls shall be built in accordance to N.E.C., U.L. and E.T.L. standards. The electrical components and enclosure shall be labeled as a complete U.L. listed assembly with manufacturer’s U.L. label applied to the door. All equipment and wiring shall be mounted within the enclosure and labeled for proper identification.

D. Provide single source responsibility for the manufacture, warranty, service, operation, and installation of the fully automatic variable speed pumping system as described in contract documents. Pumping system must conform to the following specifications in all respects. This specification covers the minimum requirements; however, it should not be construed as all inclusive.

**1.8 TESTING**

A. Notify the Contracting Officer’s Technical Representative five working days in advance of on-site testing.

B. Bump manual motor starter controls to prove correct rotation and secure local inspection/approval.

C. On completion of assembly of the pumping station, pump shall be hydrostatically tested at maximum pump shutoff head and at design flow rate.

D. Test, verify, and demonstrate to the Contracting Officer’s Technical Representative the proper operation of all control and safety shut off devices.

E. Verify flow and discharge pressure from the pump station and demonstrate, to the Contracting Officer’s Technical Representative, system performance based on the specified values.

F. Acceptance Test Prior to Final Inspection:

1. Upon completion of construction and prior to Final Inspection, an Acceptance Test must be passed.
2. Coordinate start of Acceptance Test with Contracting Officer’s Technical Representative.
3. During the Acceptance Test, the pumping system must be fully operational. The pumping system must operate with no faults for 14 consecutive days. If at any time during the 14 day test period, a system fault occurs, the source of the fault must be determined and corrected and the 14 day evaluation period will start again. If a system fault occurs, make repairs within 72 hours of notification from Contracting Officer’s Technical Representative. Document any faults in the proof of test report listing date of fault, fault, cause of the fault and the corrective action taken.
4. When the system has operated for 14 days without fault, contact the Contracting Officer’s Technical Representative to schedule Final Inspection.

**1.9 REVIEWS**

A. The purpose of on-site reviews by the Contracting Officer’s Technical Representative is to observe the Contractor's interpretation of the construction documents and to address questions with regards to the pump installation.

1. Scheduled reviews such as those for testing should be scheduled with the Contracting Officer’s Technical Representative as required by these specifications.
2. Impromptu reviews may occur at any time during the project.
3. A Final Inspection will occur at the completion of the irrigation Acceptance Test. The intent of the Final Inspection is to verify that all installation; testing; maintenance and operation submittals; and project record drawing submittals are completed prior to the start of the Maintenance and Guarantee/Warranty periods.
4. All costs, including travel expenses and site visits by the Veterans Administration or Veterans Administration representative(s) for additional Inspection(s) that may be required after the Final

Inspection due to non-compliance with the Construction Documents are the sole responsibility of the Contractor.

**1.10 GUARANTEE/WARRANTY AND REPLACEMENT**

A. The purpose of this guarantee/warranty is to insure that the Government receives materials of prime quality, installed and maintained in a thorough and careful manner.

B. The manufacturer shall warrant the pumping system to be free of defects and product malfunctions for a period of five years from date of Final Inspection including the 14 day test period by Contracting Officer’s Technical Representative.

C. The programmable controller shall be unconditionally warranted for 5 years from the date of shipment. The pumping system manufacturer shall be responsible for all warranties. Pass through warranties are not acceptable.

D. Failures caused by lightning strikes, power surges, vandalism, flooding, operator abuse, or acts of God are excluded from warranty coverage.

E. Repair damage to the premises caused by a defective item. Make repairs within 72 hours of notification from the Contracting Officer’s Technical Representative.

F. Replace damaged items with identical materials and methods per contract documents or applicable codes. Make replacements at no additional cost to the contract price.

G. Guarantee/warranty applies to originally installed materials and equipment and replacements made during the guarantee/warranty period.

**1.11 GENERAL CONSTRUCTION REQUIREMENTS**

A. Coordinate installation of pumping system with Contracting Officer’s Technical Representative and Cemetery Staff. See pumping system installation details for required coordination efforts.

B. All training to be documented and coordinated with cemetery staff. Contractor to provide service provider contact information to cemetery staff for pump station and control system.

C. Control of Excavations: See Section 3.2 for safety and access directions. Construction cannot proceed until the layout of the pumping system is reviewed and accepted by the Contracting Officer’s Technical Representative.

**PART 2 - MATERIALS**

**2.1 QUALITY**

A. Materials used in the system shall be new and without flaws or defects of any type, and shall be the best of their class and kind.

**2.2 SUBSTITUTIONS**

A. Make complete submittals of all manufacturers’ data showing compliance with the Contract Documents.

B. In making a request for a substitution to the Contracting Officer’s Technical Representative, the Contractor represents that he:

1. Has investigated the proposed substitution and found that it is the same or better quality, level, capacity, function, or appearance than the specified product, and can demonstrate that to the Contracting Officer’s Technical Representative.
2. Will coordinate the installation and make all modifications to the work, which are required for the complete installation and operation of the system.

C. The Contracting Officer’s Technical Representative will determine acceptability of the proposed substitution and will notify Contractor of acceptance or rejection.

D. Pipe sizes referenced in the construction documents are minimum sizes, and may be increased at the option of the Contractor.

**2.3 GENERAL REQUIREMENTS**

A. Provide a prefabricated skid-mounted booster pumping system with VFD controls with the capacity and discharge pressure downstream of all pump station components as shown in the construction documents. Provide variable frequency drive (VFD) motor controls with regenerative type drive.

B. Pump station must be completely piped, wired, hydraulically and electrically tested before shipment to the job site.

C. Construction must include skid assembly to support all components during shipping and to serve as the installed mounting base. Base must be of sufficient size and strength to resist twisting and bending from hydraulic forces and support the full weight of pump and motor. Skip welding is not acceptable during fabrication of the skid.

D. All components of the pump controls shall be designed to function in an outdoor environment exposed to all of the elements. Furnish protective enclosures and covers as required for proper operation of the system.

E. Construction shall include all necessary field fabrication of pipe, fittings, and supports.

F. Pump station must meet all the general and technical specifications; shall be designed, fabricated and installed in a workmanlike manner, and shall be delivered within the negotiated schedule.

G. Provide a factory-trained technician to supervise the installation of the pump station control panel and filtration assembly.

H. All pump station control components shall be supplied by and be the responsibility of one manufacturer, even though others manufactured some components.

I. Control panel must interface with irrigation control system as described in the drawings.

J. Provide all necessary hardware, wiring, panels, interfaces, and software for complete and fully operational system.

K. Acceptable Manufacturers are:

1. RAIN BIRD CORPORATION (520.741.6185)
2. WATERTRONICS (800.356.6686, 262.367.5000)
3. PRECSION PUMPING SYSTEMS (208.323.5300)
4. Or approved equal.

**2.4 PUMP**

A. Pump shall be electric motor driven, close coupled, horizontal centrifugal with mechanical shaft seal, volute case and impeller. The shaft shall be a self adjusting mechanical type.

B. The pump and motor are to be constructed so that the motor and entire rotating element can be removed from the casing without disturbing the piping.

C. All pump flanging shall have 150 psi rating. The pump casing shall be constructed from cast or ductile iron and engineered to modern hydraulic standards. The impeller shall be an enclosed, single piece bronze casting, completely machined on all outside surfaces, and dynamically balanced at time of pump assembly. The impeller shall be keyed to the shaft and securely fastened.

D. Bearings shall be of the roller or ball type of sufficient size to withstand the radial and axial thrust loads incurred during service.

E. Shaft shall be stress-proof steel accurately machined and polished and of sufficient size to transmit full driver output. Complete documentation of shaft deflection and B-10 bearing life analysis shall be included by the pump manufacture with submittals. Shafts shall be protected by a renewable shaft sleeve. The coupling shall be designed to transmit full horsepower and torque load, with an OSHA approved coupling guard.

**2.5 MOTOR**

A. Pump motor shall be squirrel cage induction horizontal solid shaft type. Pump impeller must be direct mounted and keyed to the motor shaft with a stainless steel protective sleeve. The temperature rise of the motor shall be to NEMA Standard MG-1-12.42 for class B or Class F insulation.

B. Furnish premium efficiency motor designed and rated for continuous variable speed inverter duty.

C. Radial and thrust bearings of ample capacity to accommodate the hydraulic thrust of the pump shall be incorporated into the motor. The motor shall be of proper size to drive the pump at any point on its operation curve without exceeding motor horsepower nameplate rating.

D. Motor must be compatible with VFD controls.

E. Motor must be manufactured by U.S. Motor or approved equal.

**2.6 PIPING**

A. Fabricated Piping: All fabricated piping shall conform to ASTM specifications A53 for Grade B welded or seamless pipe. Piping 16" and smaller shall be Schedule 40. All welding flanges shall be forged steel with slip-on or welding neck type. All welding fittings shall be seamless, conforming to ASTM Specification A234, with pressure rating not less than 150 PSI. All pressurized tube fittings shall be copper or brass.

B. Intake and Discharge Piping: Furnish intake and discharge piping for booster pump station constructed and fabricated from Schedule 40 carbon steel pipe and equipped with isolation valves. Piping must be painted per manufacturer’s specific color or as specified by the Contracting Officer’s Technical Representative.

**2.7 VALVES**

A. Drain Valves: Drains are to be provided from any possible low point in the system and are to consist of 1/4" brass angle valves unless otherwise noted. Drain piping is to be furnished so that no drain

water runs out on top of the deck plate. They include, but are not limited to, the following:

1. Drain in pump discharge manifold between pump check valves and control valve.
2. Drain in the bottom of each pump volute.
3. A washdown 3/4" brass hose bib shall be provided downstream of the control valve, upstream of the main station isolation valve.

B. Check Valves: Pump check valves shall be of the center pivot dual disc non-slam type, cast iron bodied with bronze and stainless steel trim. Sealing surfaces shall utilize resilient Buna N rubber.

C. Isolation Valves: Valves shall be butterfly type with the position lever or gear hand wheels and rated at 200 psi WOG working pressure. Trim shall include stainless steel stem, bronze streamlined disc, and full faced resilient seat. Isolation valves shall be installed on each pump inlet and outlet. Isolation valves downstream of the main control valve shall be rated at 150 psi.

**2.8 GAUGES**

A. Gauges and switch gauges shall be isolated from all electrical switch gear and control panels. Gauges shall be provided at appropriate locations to read inlet pressure and discharge manifold pressure. Switch gauges shall be 4-inch diameter vibration/pulsation dampened. Pressure gauges shall be 2½-inch diameter, all welded construction, constructed of stainless steel, glycerin filled, with ANSI Class B accuracy. Install ball valves to provide total isolation of all pressure gauges.

**2.9 ELECTRICAL**

A. Electrical Supply: The power supply to the station is single phase, 480 volt, 60 hertz, for full voltage across the line motor starting.

B. Enclosures:

1. The pumping station electrical controls shall be mounted in a self contained NEMA 4 (minimum NEMA rating) enclosure with a drip lip fabricated from not less than 14 gauge steel. Door gasket seals shall be neoprene sponge, sufficient to protect interior components from weather and dust. The electrical panel doors shall be constructed from 12-gauge steel with integral locking screws and latches.

2. Provide operating handle for the main station power disconnect on the front of the panel. Furnish weatherproof and dust proof external operating devices.
3. All internal components of the enclosures shall be mounted on removable back panels. Mounting screws for components shall not be tapped in the panel enclosure.
4. All internal wiring within, and interconnecting between, the panels shall be complete and no field wiring within the panels shall be required. Wiring troughs and cable raceways shall be self-contained within the enclosures and no external cable trays or wiring troughs are permitted.
5. No pressure gauges, pressure switches, water activated devices, or water lines of any sort shall be installed in any electrical control panel. All adjustments and maintenance shall be able to be done from the front of the control enclosure. A complete wiring circuit and legend with all terminals, components, and wiring identification shall be provided. Main disconnect shall be interlocked with door.
6. All electrical starter and control panels shall be assembled from components that are U.L. listed and each completed panel shall be U.L. listed as an Industrial Control Panel.
7. Furnish air conditioned cooling system to cool the enclosure and reject heat from the VFD. Open type cooling systems allowing outside ambient air to enter the panel are not acceptable.
8. Provide corrosion inhibiting modules in accordance with the manufacturer’s recommendations.

C. Pump Motor Starters, Disconnect, and Electrical Switch Gear:

1. The pump motor starters shall be contained within the pump station control enclosure with a double access doors and main disconnect. Each starter shall be protected on each power leg by a time delay fuse of the appropriate amperage. Motor starter coils shall be 120 volt operated with voltage obtained from integral control power transformer.
2. Overload relays shall be ambient-compensating type installed on each power leg and shall be set to trip at 105% of motor full-load current rating.
3. Motor must have dual contactors, which are both electrically and mechanically interlocked to allow the VFD to operate.

D. Variable Speed Master Controls and Display:

1. Provide complete instrumentation and controls to automatically start, stop and modulate pump speed(s) to smoothly, efficiently and reliably pump variable flow rates at a constant discharge pressure. Provide full alarms and safety features needed to protect the equipment and irrigation piping system.
2. Variable Frequency Drive: Provide a digital, pulse width modulation (PWM) variable frequency drive (VFD) with IGBT transistors.
   a. Provide a regenerative type drive capable of converting the single phase power source to three phase.
   b. Provide VFD with a minimum wire to wire efficiency of 98.5%, and shall be rated up to 550-volt operation in order to eliminate nuisance tripping at marginally high voltage conditions.
   c. Provide VFD with the front end protected by fast acting semiconductor fuses. Any VFD error messages shall be displayed on LCD readout in English or any one of eight other languages.
   d. Include the following fault protection circuits: Over-current (200%), over-voltage (130%), under-voltage (60%), over-temperature ($70^{o}$ C), ground fault, and motor overload.
   e. Provide VFD capable of starting into a rotating load and accelerate or decelerate to setpoint without safety tripping.
   f. Provide VFD with an automatic extended power loss ride through circuit, which will utilize the inertia of the pump to keep the drive powered. The minimum power loss ride-through shall be one cycle based on full load and no inertia.
   g. Provide VFD optimized for a 3 kHz carrier frequency to reduce motor noise and employing three current limit circuits to provide "tripless" operation.
   h. The following operating information shall be displayed on the VFD LCD: KWH, elapsed time, Output frequency (Hz), motor speed (RPM), motor current (amps), and voltage. Line reactor will be installed on input of VFD to protect against voltage transients.
3. Pressure Transducer:
   a. Pressure transducer shall be utilized for providing all pressure signals for the control logic.
      (1) Provide a solid-state bonded strain gauge type pressure transducer with an accuracy of plus/minus 0.20%. Housing shall

be stainless steel NEMA 4X with 304L stainless steel wetted parts. Plastic transducer housings are not acceptable.

(2) Furnish a transducer rated for station discharge pressure as shown on technical data sheet, which will provide gauge pressure output, rather than an absolute.

4. Controls:

a. All control logic shall be handled by an industrial grade programmable logic controller (PLC) with a 40 character LED industrial operator interface providing data entry and read-out capabilities.

(1) Provide PLC with LED indicators for input, output, and four (4) diagnostic read-outs showing PC Run, CPU Fault, I/O Fault, and communication. Provide an LED visual status light for each I/O to indicate on/off status.

(2) Provide PLC with a built in EEPROM, capacitor, and battery for memory backup. A surge suppressor shall be mounted on input of PLC for power transient suppression.

(3) All logic for system control, timing, and control of VFD speed shall be handled by the PLC. No external relay logic and/or timers are permitted. A separate set point controller is not acceptable.

(4) PLC shall have a built in clock calendar.

b. PLC must provide output to communication cable path to future computer for remote monitoring software. Computer and remote monitoring software are not part of this contract.

5. Alarms and Shutdowns:

a. Low discharge pressure (with override switch)*

b. High discharge pressure

c. Low lake level (Attempts restart)*

d. Phase loss (Attempts restart)*

e. Low voltage (Attempts restart)*

f. Phase unbalance (Attempts restart)*

g. Individual motor overload/phase loss (indicates which individual motor was shut down)

h. VFD fault (shutdown VFD pump only and attempts restart).*
*Three failed restarts in 15-minute period will give hard shutdown.

i. A red general alarm light will indicate all alarms. Specific alarm conditions along with procedures for correction will be displayed in English on the operator interface display (OID).

6. Panel face switches and lights:
   a. Individual pump run lights and pump on/off switches
   b. System Hand/Off/Automatic switch
   c. Mode Select switch -- allows automatic bypass mode of operation that can be used if VFD should fail.
   d. VFD selector switch -- in manual mode, allows user to select which pump will be run off the VFD.
   e. Reset -- Acknowledges pump station alarms
   f. Speed potentiometer -- in manual mode allows user to adjust VFD pump speed
   g. Low discharge pressure override switch -- disables low discharge pressure alarm
   h. PLC bypass switch mounted inside panel allows user to manually operate pump should PLC fail.
7. Software:
   a. Software will be included to automatically and gradually ramp up irrigation system pressure to the desired operating pressure (i.e., 1 PSI every 3 seconds) without overshooting design pressure. This feature operates whenever pressure drops below set point pressure. This ramp up time is fully adjustable by the operator. This control feature is based on an increase in pressure over a pre-defined time period. The acceleration control on the VFD is NOT an acceptable means of adjusting pressure ramp up speed.
   b. Software will be included for optionally maintaining a lower irrigation system pressure when not irrigating. Reduced pressure values will be shown in the technical data sheet. Controls will cycle the PM pump at these reduced pressures during non-irrigation times and pressure will gradually increase to design pressure when the irrigation periods begin.
   c. Neither flow meter nor VFD output frequency shall be used for shutting down last VFD driven pump. Controls and software shall

incorporate a method to eliminate excessive cycling of VFD pump at very low flow conditions, yet not run the pump excessively at no flow conditions.

d. Provide automatic alternation of VFD driven pump accomplished by incorporating dual mechanically and electrically interlocked contactors allowing alternation of the VFD between pump.
e. Real time clock calendar allows PLC to internally provide all date and time functions used above.
f. Two separately adjustable PID control loops for both low flow and high flow pressure stability.
g. Provide system that allows user to field select either two modes of VFD operation. Auto switch VFD option allows VFD to sequentially start each pump. The standard mode of operation starts the first main pump on the VFD and the remaining pump starts across the line as required.
h. Shutoff algorithm for pump should minimize pump cycling.
i. Full manual operation capability with panel face mounted speed potentiometer for manually adjusting VFD speed.
j. System can be immediately and directly switched from manual to automatic mode of operation. This allows for manual pressurization and immediate switching capability to automatic.
k. Light test sequence. Pressing the reset button for 5 seconds illuminates all lights.
l. Rate of pressure change algorithm to rapidly determine if there is an irrigation demand and immediately cycle on the VFD pump, in lieu of waiting for pressure to drop to a predetermined start pressure.
m. All pump station shutdowns shall be of the controlled type which sequentially phase pump off at user selectable internals to reduce water hammer within the irrigation system.
n. Pump monitoring software on Central Computer must be provided by pump manufacturer and compatible with Windows 8. This software must only monitor pump status and provide same information as Operator Interface Device (OID).

8. Operator Interface Device (OID):
   a. The pump station shall include a NEMA 4, 40 character LED display and keypad mounted on the control panel door. This device will allow the operator to view and selectively modify all registers

in the PLC. The unit shall store its messages in non-volatile memory. The operator interface device shall incorporate password protection for protecting data integrity. The device will allow for display and modification of all timers, set points, lockout times, etc. The device shall communicate with the PLC through the programming port, and shall include an RS232 communications port allowing a printer to be attached for real time station status logging.

b. The OID shall be an information system only and not required for pump station operation. No switches, reset buttons, general alarm light, run lights or speed potentiometers are included within this unit. This pump station will be fully functional in the event the OID unit should fail.

c. In addition to normal data entry keys, the device shall include a minimum of the following function keys labeled:

(1) Event. Displays one of three data logging functions.

(a) Operator can scroll through the historical pump station flows and pressures for up to the last 7 days. The operator can change sampling time periods (from 1 to 60 minutes). Averages are taken over the sample period and the average recorded with time stamp.

(b) The last 128 sequential pump station events with time of occurrence. Events shall include but not be limited to: all alarms, starting of individual pump, stopping of individual pump and changing of selector switches.

(c) Station flow and pressure are shown every second for the previous 60 seconds and every minute for the previous 30 minutes. If a shutdown occurs, the flow and pressure tables are locked in so that the operator may view how the pump station was performing immediately before the shutdown occurred.

(2) Status. Will display the current operating status. When the station is running, the display will show the setpoint pressure, actual pressure, flow, and pump rpm.

(3) Alarm Info. It will display detailed information on the alarm, time of occurrence, pump operating at time of alarm and how to correct the alarm condition.

(4) Daily Log. It will display the following: Last time of log reset, individual pump run times, run times since last reset, pump starts, pump starts since last reset, total flow, total flow since last reset, highest flow rate with time of occurrence, alarm conditions, and times since last reset.

(5) Scroll Key. Used to scroll up and down through data.

9. Operation:

a. During non-irrigation times, pump will cycle on and off as required to maintain irrigation system pressure. The cycling pressures can be user selected and can be set substantially below normal set point pressure, if desired.

b. The pump speed will be modulated to hold a constant discharge pressure regardless of flow.

E. Skid Wiring:

1. All wiring from control panels to motor shall be in liquid-tight conduit with copper conductors rated not less than 600 volts AC and of proper size to carry the full load amperage of the motor without exceeding 70% capacity of the conductor. A grounding cable shall be included in the liquid-tight conduit. There shall be no splices between the motor starters and the motor connection boxes.

2. Wiring to flow sensors and pressure transducer shall be multi-conductor shielded cable suitable for Class ll low voltage controls.

F. Lightning Arrestor:

1. Equip main power supply feeding the pumping station with a 3 phase secondary lighting arrestor having a breakdown current rating of not less than 60,000 amps at 14,000 volts discharge. Power supplies, 300 volts and less, shall use 300 volt rated arrestor with an 800 volt spark-over voltage. Power supplies 301-600 volts shall use 600 volt rated arrestors with a 1,000-volt spark-over voltage.

G. Grounding:

1. Furnish grounding equipment required by pump station manufacturer to adequately protect the pump station control panel and pump and motor.

2. Coordinate grounding of pump station control panel with electrical plans.

H. Misc. Electrical Components

1. Main Station Disconnect: A three-pole main station disconnect shall be mounted in the pump station’s main NEMA 3R enclosure to

completely isolate the electrical system from incoming power. Disconnect shall conform to the requirements of the NEC and applicable local codes. The main station disconnect shall have an operating handle on the front of the panel.

2. Secondary Control Circuit Fuses: Single-pole secondary distribution fuses with appropriate ratings shall supply power to each pump starter coil circuit, the control system, and to other circuits as required.
3. Low System Pressure Safety Shutdown: Low discharge pressure is to be sensed by the pump starting set point. When the station discharge pressure decreases to this point and maintains a start signal for a preset time, the pump will be de-energized and remains so until the circuit is manually reset. An indicator light shall illuminate to indicate a low discharge pressure shutdown has occurred.
4. Corrosion Inhibiting Modules: Corrosion inhibiting modules shall be installed in all electrical enclosures in accordance with the manufacturer's recommendations.

I. Standards:

1. All wiring shall conform to the National Electrical Code Standards. Flexible conduit sections shall be less than 5 feet in length. All conduit to devices shall be attached securely to avoid trip hazards.
2. The manufacturer shall provide a wiring schematic. The schematic shall show all devices, connections and wire numbers.
3. All controls and electrical equipment shall be thoroughly inspected and tested before shipment.

**2.10 FLOW SENSOR**

A. Provide magnetic type flow sensor with multiple pulse outputs, KROHNE Optiflux 2000 or equal.

**2.11 HEATER**

A. Provide heater properly sized to heat the pump, motor, switchgear and control logic and piping within enclosure. Heater must be located inside and mounted to the pump enclosure. The heater must maintain a temperature above freezing within the enclosure. Heater to be used only for late season and early season operation.

**2.12 ENCLOSURE**

A. Provide a protective, insulated and painted enclosure sized to house all components. Enclosure must open in such a manner to allow access to

all components for maintenance. Use an aluminum enclosure or approved equal.

**2.13 PAINTING**

A. Painting of the entire unit shall consist of a multi-step coating system which includes metal preparation, rust inhibitive prime coat, and a two part polyurethane finish having a total dry film thickness of not less than 4 mils.

B. Pump station components shall be painted the manufacturer's standard color. All electrical enclosures and accessory panels shall be painted to a minimum thickness of 3 mils and baked at 160-180$^{o}$ F.

C. Provide a 1-quart can of the finish paint with the system for job site touch up use.

**2.14 OTHER COMPONENTS**

A. Tools and Spare Parts: Provide operating keys, servicing tools, test equipment, and any other items indicated on the drawings.

B. Other Materials: Provide other materials or equipment shown on the drawings or installation details to be part of the pumping system, even though such items may not have been referenced in these specifications.

**PART 3 - EXECUTION**

**3.1 INSPECTIONS AND REVIEWS**

A. Site Inspections:

1. Verify site conditions and note irregularities affecting work of this section. Report irregularities to the Contracting Officer’s Technical Representative prior to beginning work.
2. Beginning work of this section implies acceptance of existing conditions.

**3.2 EXCAVATION AND BACKFILLING**

A. Install and maintain safety fencing around all unattended excavation. Place safety signs adjacent to construction area roadway to the satisfaction of the Contracting Officer’s Technical Representative.

**3.3 SHIPPING AND OFF-LOADING**

A. Contractor must furnish and coordinate shipping and off-loading of pump station. Location and mounting detail shall be furnished to the Contractor by the pump station manufacturer.

**3.4 PUMP STATION INSTALLATION**

A. Align pump station piping with inlet and discharge pipe prior to finalizing fabrication.

B. Anchor filter assembly to concrete mounting pad and complete all piping connections prior to technical start-up, testing and operation.

C. Electrical connection shall consist of a single conduit from 3 phase 460 volt disconnect to the pump station main disconnect.

**3.5 TECHNICAL START-UP**

A. Pump station manufacturer must conduct technical start-up of the pump station. Procedures should include:

1. Station start-up and pressurization.
2. Pressure, flow, automatic shut-down and programming adjustments
3. Monitoring of irrigation cycle when possible. Technician will instruct operations personnel as to the operation, adjustment and maintenance of the pump station.

**3.6 INSTALLATION OF OTHER COMPONENTS**

A. Tools and Spare Parts: Prior to the Final Inspection supply operating keys, servicing tools, test equipment, and any other items indicated on the drawings.

B. Other Materials: Install other materials or equipment shown on the drawings or installation details to be part of the pumping system, even though such items may not have been referenced in these specifications.

**3.7 MAINTENANCE AND OPERATION INSTRUCTIONS**

A. Pumping System Maintenance:

1. Prior to Final Inspection, provide two training sessions to operating personnel on proper operation and maintenance of the pumping system. Training sessions should be for a period of not less than 1-hour each, scheduled on two different days and cover aspects of maintaining, operating and repairing the pumping system.
2. Unless otherwise noted, provide irrigation operation and maintenance information in a 3-ring binder with table of contents and index sheet. Provide sections that are indexed and labeled. Provide the following information:
   a. Catalog cut sheets for pumping system.
   b. Manufacturer’s Operation and Maintenance manuals including complete documentation for programming and recommended settings and adjustments.
   c. Manufacturer’s Technical Service Bulletins.
   d. Manufacturer’s Warranty Documentation.
   e. Manufacturer’s guide for troubleshooting operational problems.

f. Recommended routine maintenance inspections for weekly, monthly and annual inspections and recommended actions for the inspections, recommended method for recording the findings of the inspections and winterization.

g. Predictive schedule for component replacement.

h. Listing of technical support contacts.

3. Operation and maintenance submittal package must be complete prior to being reviewed by the Contracting Officer’s Technical Representative. Incomplete submittals will be returned without review.

**3.8 PROJECT RECORD DRAWINGS**

A. The Contractor is responsible for documenting installed system and all changes to the design. Maintain on-site and separate from documents used for construction, one complete set of contract documents as Project Documents. Keep documents current. Do not permanently cover work until as-built information is recorded.

B. Record pumping system alterations. Record work, which is installed differently than shown on the construction drawings. Record accurate reference dimensions.

C. Prior to project completion label each sheet of the project drawings (redlines) as “Record Drawing" and turn over to Contracting Officer’s Technical Representative for delivery to Engineer. Completion of the Record Drawings is a prerequisite for Final Inspection.

**3.9 MAINTENANCE**

A. Operate and maintain pumping system for a duration of 30 calendar days from Final Acceptance. Make periodic examinations and adjustments to pumping system components as necessary so as to achieve the most desirable operation.

**3.10 CLEANUP**

A. Upon completion of work, remove from the site all machinery, tools, excess materials, and rubbish.

B. Clean all surfaces and touch up scratches on pumping system or piping with factory paint to match original.

- - - END - - -

# SECTION 32 84 00
# PLANTING IRRIGATION

## PART 1 - GENERAL

### 1.1 DESCRIPTION

A. Contractor is responsible for providing a system with full and complete coverage. Furnish all labor, materials, supplies, equipment, tools, and transportation, and perform all operations in connection with and reasonably incidental to the complete installation of the irrigation system, and guarantee/warranty as shown on the drawings, the installation details, and as specified herein. Items of work specifically included are:

1. Procurement of all applicable licenses, permits, and payment of required fees.
2. Coordination of Utility Locates public and private ("Call Before You Dig").
3. Maintenance period.
4. Sleeving for irrigation pipe and wire.
5. Booster pump station.
6. Control system capable of stand alone operation with the ability to be upgraded to a “cloud” based system in the future.

### 1.2 RELATED WORK

A. Section 26 ELECTRICAL
B. Section 32 82 00 IRRIGATION PUMP STATION
C. Section 32 90 00 PLANTING

### 1.3 QUALITY ASSURANCE

A. Contractor:

1. Irrigation Contractor must have demonstrated, using persons directly employed by the Contractor, experience with the installation of at least five (5) irrigation systems having large diameter HDPE pipe (3-inch and larger); electro fusion fittings and butt fusion fittings and joints; control systems with electrically operated remote control valves; large radius rotary sprinklers (minimum 1-inch inlet with swing joint) and pre-fabricated booster pump stations.

2. Contractor and project superintendent must be trained by control system manufacturer for installation of control system installation and programming. Provide documentation from control system manufacturer regarding training.
3. Contractor must be registered in Illinois.
4. Provide documentation of contractor qualifications with equipment submittals.

B. Equipment Manufacturer:
1. Manufacturer regularly and presently manufactures the item as one of their principal products.

C. System Requirements:
1. Full and complete coverage is required. Contractor shall, at no additional cost to the Government, make necessary adjustments to layout required to achieve full coverage of irrigated areas.
2. Layout work as closely as possible to drawings. Drawings are diagrammatic to the extent that swing joints, offsets and all fittings are not shown.

**1.4 SUBMITTALS**

A. Make submittal and provide number of copies per Specification Section 01 33 23. Unless otherwise noted, provide four (4) copies of irrigation information in a 3-ring binder with table of contents and index sheet. Provide sections that are indexed and labeled for valves, sprinklers, pipe and fittings, wire and wire connectors, ID tags, shop drawings and all other irrigation equipment shown or described on the drawings and within these specifications. Highlight items being supplied on the catalog cut sheets. Submittal package must be complete prior to being reviewed by the Contracting Officer’s Technical Representative. Incomplete submittals will be returned without review.

B. Materials List: Include all materials and products that are part of the irrigation system including, but not limited to: pipe, fittings, valves, mainline components, water emission components, and control system components. Quantities of materials need not be included.

C. Manufacturers' Data: Submit manufacturers' catalog cuts, specifications, and operating instructions for equipment shown on the materials list. For rotary sprinklers include Center for Irrigation Technology SpacePro Single Leg Profile showing the Distribution

Uniformity and Scheduling Coefficient for the nozzles being used at the specified offset spacing.

D. Shop Drawings: Submit shop drawings called for in the installation details. Show products required for proper installation, their relative locations, and critical dimensions. Note modifications to the installation detail.

E. Testing: Submit a proof of testing report following completion of each test listed in Part 1 of these specifications. Unless otherwise noted, include name of test, date of test, name of the individual completing the test, name of the company completing the test and a summary of the test results. If system fails test, document any and all retests until system passes test.

F. Maintenance and Operation Instructions: Submit information listed in Part 3 of these specifications.

G. Record Drawings: Submit information listed in Part 3 of these specifications.

**1.5 APPLICABLE PUBLICATIONS**

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. Federal Specifications (Fed. Spec.): RR-F-621E Frames, Covers, Gratings, Steps, Sump And Catch Basin, Manhole

C. American National Standard Institute (ANSI):

B40.1-91.....Gauges-Pressure Indicating Dial Type Elastic Element

D. American Society of Agricultural Engineers (ASAE):

S398 .....Sprinkler Testing and Performance Reporting.

E. American Society for Testing and Materials (ASTM):

B61-93.....Steam or Valve Bronze Castings

B62-93.....Composition Bronze or Ounce Metal Castings

D1785-91.....Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedule 40, 80, and 120

D2241-89.....Poly(Vinyl Chloride) (PVC) Pressure Rated Pipe (SDR Series)

D2287-81.....Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds

D2464-91.....Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

D2466-90.....Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40

D2564-94.....Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Pipe And Fittings

D2855-96.....Making Solvent Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings

D3350.....Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

F714.....Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter

F477-90.....Elastomeric Seals (Gaskets) for Joining Plastic Pipe

F2164.....Field Leak Testing of Polyethylene Pressure Piping Systems

B209-96.....Aluminum and Aluminum-Alloy Sheet and Plate

F. American Water Works Association (AWWA):

C110-93.....Ductile-Iron and Gray-Iron Fittings, 3-Inch Through 48-Inch for Water and Other Liquids

C111-90.....Rubber Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe Fittings.

C115-94.....Flanged and Ductile Iron and Gray Iron Pipe with Threaded Flanges

C151-93.....Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand Lined Molds, for Water or Other Liquids

C153-94.....Ductile-Iron Compact Fittings, 3 Inch Through 12-Inch for Water and Other Liquids.

C500-93.....Gate Valves for Water and Sewerage Systems

C504-87.....Rubber Sealed Butterfly Valves

C600-93.....Installation for Ductile-Iron water Mains and Their Appurtenances

C901-02 Polyethylene (PE) Pressure Pipe and Tubing, ½ In. (13 mm) Through 3 In. (76 mm), for Water Service

G. Irrigation Association (IA): Technical Resources, Irrigation Best Practices & Standards

H. Manufacturers Standardization Society (MSS):

SP70-90.....Cast Iron gate Valves, Flanged and Thread Ends

I. National Electrical Manufacturers Association (NEMA):

250-85 Enclosures for Electrical Equipment (1000 Volts Maximum); Revision 1, May 1986

J. National Electric Code: (latest edition 2011)

K. Uniform Plumbing Code: (latest edition)

**1.6 RULES AND REGULATIONS**

A. Work and materials will be in accordance with the latest edition of the National Electric Code, the Uniform Plumbing Code, and applicable laws and regulations of the governing authorities.

B. When the contract documents call for materials or construction of a better quality or larger size than required by the above-mentioned rules and regulations, provide the quality and size required by the contract documents.

C. If quantities are provided either in these specifications or on the drawings, these quantities are provided for information only. It is the Contractor's responsibility to determine the actual quantities of all material, equipment, and supplies required by the project and to complete an independent estimate of quantities and wastage.

**1.7 AVAILABILITY AND USE OF UTILITY SERVICES**

A. The government shall make NO utilities available to the Contractor from existing outlets and supplies. Upon completion of the irrigation system or completion of portions thereof. After the contractor has installed

the automatic filter downstream of the renovated pumping system, water will be available for flushing and testing of the new irrigation system. The contractor may use water at no cost through the irrigation system for establishing turf and maintaining plant material. No other expressed or implied uses of government furnished water exist.

B. The Contractor, at Contractor's expense and in a workmanlike manner satisfactory to the Resident Engineer, shall install and maintain all necessary temporary connections and distribution lines, and meters required by the public utilities. Before final acceptance of the work by the Government, the Contractor shall remove all the temporary connections, distribution lines, meters, and associated appurtenances.

**1.8 TESTING**

A. Notify the Contracting Officer’s Technical Representative five working days in advance of testing.

B. Pipelines jointed with solvent-welded PVC joints will be allowed to cure at least 24 hours before testing.

C. Subsections of mainline pipe may be tested independently, subject to the review of the Contracting Officer’s Technical Representative.

D. Furnish clean, clear water, pumps, labor, fittings, and equipment necessary to conduct tests or retests.

E. Hydrostatic pressure testing of HDPE pipe must be conducted in accordance with ASTM F2164, Field Leak Testing of Polyethylene Pressure Piping Systems Using Hydrostatic Pressure. Fill HDPE pipe with water, raise to test pressure and allow to stabilize. Test pressure must be 1.5 times the operating pressure at the lowest point in the system. In accordance with ASTM F2164 Section 9.8, pipe will pass test if the final pressure is within 5% of the test pressure for 1 hour. For safety reasons, hydrostatic testing only will be used.

   1. Purge air from pipe before test. Attach pressure gauge to a riser in the middle of the pipe section being tested.
   2. Cap all risers.
   3. Backfill to prevent pipe from moving under pressure.

F. Hydrostatic Pressure Test – Solvent Weld Lateral Pipe:

   1. Subject pipe to a hydrostatic pressure equal to the anticipated operating pressure of 90 PSI for 30 minutes.

2. Cap all sprinkler risers.
3. Backfill to prevent pipe from moving under pressure. Expose couplings and fittings.
4. Leakage will be detected by visual inspection. Replace defective pipe, fitting, joint, valve, or appurtenance. Repeat the test until the pipe passes test.
5. As an alternative to the visual inspection described in Item 4. above, the Contracting Officer’s Technical Representative may request that a pressure drop test be performed:
   a. Purge air from pipe before test. Attach pressure gauge to a riser in the middle of the lateral. Cap all sprinkler risers.
   b. Pressurize the lateral via the remote control valve then turn down flow control handle on remote control valve to seal off lateral.
   c. Observe pressure loss on pressure gauge. If pressure loss is greater than 5 PSI, identify reason for pressure loss. Replace defective pipe, fitting, joint, valve, or appurtenance. Repeat test until pressure loss is equal to or less than 5 PSI.
6. Cement or caulking to seal leaks is prohibited.
7. After lateral passes test and prior to operational test, install sprinklers and backfill and compact all pipe, fittings, joints, or appurtenance.

G. Booster Pump:
   1. On completion of installation of the pumping station, all discharge pipe and valves shall be hydrostatically tested at maximum pump shutoff head.

H. Operational Test –Remote Control Valves, Lateral Piping and Sprinklers:
   1. Activate each remote control valve in sequence from each controller using the remote control valve. Manual operation of the valves is not an acceptable method of activation. The Contracting Officer’s Technical Representative will visually observe operation, water application patterns, and leakage.
   2. Replace defective remote control valve, solenoid, wiring, or appurtenance to correct operational deficiencies.
   3. Replace, adjust, add, or move water emission devices to correct operational or coverage deficiencies.

4. Replace defective pipe, fitting, joint, valve, sprinkler, or appurtenance to correct leakage problems. Cement or caulking to seal leaks is prohibited.
5. Repeat test(s) until each lateral pass all tests. Repeat tests, replace components, and correct deficiencies at no additional cost to the Owner.

I. Distribution Uniformity (DU):

1. Perform a DU Test on ten zones (8 rotor zones and 2 spray zones.
2. In conjunction with the Contracting Officer’s Technical Representative, select the zones of sprinklers that are representative of the area being irrigated by the controller.
3. Perform a catch can test using procedures recommended by the Irrigation Association.
4. Calculate and provide a written documentation of the DU for each zone tested. Documentation to include map indicating obtained data and location where testing was conducted.
5. An Irrigation Association Certified Landscape Irrigation Auditor must perform the test. Provide written evidence of certification prior to conducting test.

J. Control System Grounding:

1. Test for proper grounding of control system per manufacturer's recommendations. Test results must meet or exceed manufacturer's guidelines for acceptance.
2. Replace defective wire, grounding rod or appurtenances. Repeat the test until the manufacturer's guidelines are met.
3. If the test is acceptable, the individual completing the test must document the results of the grounding test on the inside of each controller pedestal door and via a written report. Documentation should include satellite name or number, date of test, and the ohms resistance to ground. The test results should be marked on the inside of each controller pedestal door using a permanent marker.
4. A written report of the test data listing controller name or number, date of test, name of the individual completing the test, name of the company completing the test and the ohms resistance

to ground for each controller must be submitted to the Contracting Officer’s Technical Representative.

K. Acceptance Test Prior to Final Inspection:

1. Upon completion of construction and prior to Final Inspection, an Acceptance Test must be passed.
2. Coordinate start of Acceptance Test with Contracting Officer’s Technical Representative.
3. During the Acceptance Test, the irrigation system must be fully operational from the control system. The irrigation system must operate with no faults for 14 consecutive days. If at any time during the 14 day test period, a system fault occurs, the source of the fault must be determined and corrected and the 14 day evaluation period will start again. If a system fault occurs, make repairs within 24 hours of notification from Contracting Officer’s Technical Representative. Document any faults in the proof of test report listing date of fault, fault, cause of the fault and the corrective action taken.
4. If the fault is found to be due to factors outside of the contractor’s control (for example, mainline pipe break in area not being renovated) the evaluation period will continue. The time required to make the repair shall not be included in the evaluation period.
5. When the system has operated for 14 days without fault, contact the Contracting Officer’s Technical Representative to schedule Final Inspection. Substantial completion consideration is only given after the 14 day test has been accepted.

## 1.9 CONSTRUCTION REVIEWS

A. The purpose of on-site reviews by the Contracting Officer’s Technical Representative is to periodically observe the work in progress, the Contractor's interpretation of the construction documents, and to address questions with regard to the installation.

1. Schedule reviews for irrigation system layout or testing with the Contracting Officer’s Technical Representative as required by these specifications.
2. Impromptu reviews may occur at any time during the project.

3. A Final Inspection will occur at the completion of the irrigation Acceptance Test. The intent of the Final Inspection is to verify that all installation; testing; maintenance and operation submittals; and project record drawing submittals are completed prior to the start of the Maintenance and Guarantee/Warranty periods.
4. All costs, including travel expenses and site visits by the Veterans Administration or Veterans Administration representative(s) for additional Inspection(s) that may be required after the Final Inspection due to non-compliance with the Construction Documents are the sole responsibility of the Contractor.

**1.10 GUARANTEE/WARRANTY AND REPLACEMENT**

A. The purpose of this guarantee/warranty is to insure that the Government receives irrigation materials of prime quality, installed and maintained in a thorough and careful manner.

B. Guarantee/warranty irrigation materials, equipment, and workmanship against defects for a period of one year from Final Inspection by Contracting Officer’s Technical Representative. Fill and repair depressions. Restore landscape, utilities, structures or site features damaged by the settlement of irrigation trenches or excavations. Repair damage to the premises caused by construction or a defective item. Make repairs within 24 hours of notification from Contracting Officer’s Technical Representative.

C. Replace damaged items with identical materials and methods per contract documents or applicable codes. Make replacements at no additional cost to the contract price.

D. Guarantee/warranty applies to originally installed materials and equipment and replacements made during the guarantee/warranty period.

**1.11 GENERAL CONSTRUCTION REQUIREMENTS**

A. Coordinate construction of irrigation system with Contracting Officer’s Technical Representative. See irrigation plans and installation details for required coordination efforts related to the installation of specific irrigation components.

B. Install irrigation components in landscaped areas only.

C. Construction cannot proceed unless staking of irrigation mainline, isolation gate valve locations, quick coupling valve locations, remote

control valve locations, sprinkler, and controller locations are reviewed and accepted by the Contracting Officer’s Technical Representative.

**PART 2 - PART 2 - MATERIALS**

**2.1 QUALITY**

A. Use new materials without flaws or defects.

**2.2 SUBSTITUTIONS**

A. Unless noted otherwise, use specified equipment. Contracting Officer’s Technical Representative must approve equipment prior to construction. The Contactor through written request prior to purchase or installation may request substitutions to the approved equals listed herein. Changes and associated design costs to accommodate alternative equipment are Contractor’s.

B. Pipe sizes and pressure ratings referenced in the construction documents are a minimum and may be increased at Contractor’s option.

**2.3 SLEEVING**

A. Provide sleeve beneath hardscape for PVC irrigation pipe and wiring that cannot be horizontally bored. Provide separate sleeve beneath hardscape for wiring.

B. Use high density, extra high molecular weight polyethylene pipe (HDPE), extruded from material meeting the specifications of cell classification on PE 345434C, ASTM standard D 3350, SDR 11, rated at 160 PSI conforming to the dimensions and tolerances established by ASTM F 714 for mainline pipe.

C. Pipe sleeve sizes to be twice the diameter of the pipe routed through the sleeve. Wiring bundle contained in the sleeve should not exceed 40% of the available area within the sleeve per NEC recommendations.

D. HDPE mainline pipe does not require sleeves when directionally bored.

**2.4 PIPE AND FITTINGS**

A. HDPE Mainline Pipe and Fittings:

1. Use high density, extra high molecular weight polyethylene pipe (HDPE), extruded from material meeting the specifications of cell classification on PE 345434C, ASTM standard D 3350, SDR 9, rated at 200 PSI conforming to the dimensions and tolerances established by ASTM F 714 for mainline pipe.

2. Join pipe lengths using butt-fusion technique as recommended by pipe manufacturer.
3. Join HDPE to PVC pipe materials using HDPE (butt-fusion) x adapter with ductile iron back-up ring.

B. Lateral Pipe and Fittings:
1. Use rigid, unplasticized polyvinyl chloride (PVC) 1120, 1220 National Sanitation Foundation (NSF) approved pipe, extruded from material meeting the requirements of Cell Classification 12454-A or 12454-B, ASTM Standard D1784, with an integral belled end suitable for solvent welding.
2. Use Class 160, SDR-26, rated at 160 PSI, conforming to dimensions and tolerances established by ASTM Standard D2241. Use PVC pipe rated at higher pressures than Class 160 in the case of small nominal diameters not manufactured in Class 160.
3. Use solvent weld pipe for lateral pipe. Use Schedule 40, Type 1, PVC solvent weld fittings conforming to ASTM Standards D2466 and D1784 for PVC pipe. Use primer approved by pipe manufacturer. Solvent cement to conform to ASTM Standard D2564, of type approved by pipe manufacturer.

C. Specialized Pipe and Fittings:
1. Use mechanical joints conforming to ANSI A 21.10 (AWWA C110) and ANSI A21.11 (AWWA C111) or flanged fittings conforming to ANSI/AWWA C110 and ANSI B16.1 (125#).
2. Joint sealant: Use only teflon-type tape or teflon based paste pipe joint sealant on plastic threads. Use nonhardening, nontoxic pipe joint sealant formulated for use on water-carrying pipes on metal threaded connections.

## 2.5 MAINLINE COMPONENTS

A. Tap and Meter Assembly:
1. General:
   a. As presented in the installation details.
   b. Components to comply with Sugar Creek Water District rules and regulations.
2. Tapping Saddle: Use stainless steel tapping saddle w/ RSW tapping value compatible with a wet tap connection.

3. Water Meter: Use a Badger water meter compatible with Sugar Creek Water District rules and regulations. Include y-strainer and AMR/radio read system.
4. Master Valve: Use ductile iron body flanged normally open master valve with 24VAC operable solenoid. Acceptable manufacturers are Cla-Val or approved equal.
5. Pre-cast Concrete Vault: Use vault sized as presented in installation details. Vault to be complete with floor, man-hole access, man-hole cover and winterization plug.

B. Backflow Preventer/Booster Pump Assembly:

1. General:
   a. As presented in the installation details.
   b. Provide a prefabricated system complete with backflow preventer, booster pump, piping, valves, electrical controls and all components shown in the installation detail.
   c. Construction must include skid assembly to support all components during shipping and to serve as the installed mounting base.
   d. Assembly must be designed, fabricated and installed in a workmanlike manner.
   e. All components of the assembly must be designed to function in an outdoor environment exposed to all of the elements.
   f. Provide a factory-trained technician to supervise the installation of assembly.
   g. Assembly must be supplied by and be the responsibility of one manufacturer, even though others manufactured some components.
   h. Assembly must be completely piped, wired, hydraulically and electrically tested on structural steel skid before shipment to the job site.
2. Backflow Preventer: Use a reduced pressure principal backflow prevention device, ductile iron valve body with fusion epoxy coating, bronze relief valve and trim, stainless steel springs, OS&Y and NRS shut-offs and rated for maximum 175 PSI working pressure. Valve setter to be compatible with backflow preventer. Acceptable manufacturer and model is Febco 880V, Wilkins 475 Series or approved equal.

3. Booster Pump:
   a. Provide a prefabricated skid-mounted pumping station as described in Section 32 82 00 that automatically maintains a constant discharge pressure regardless of varying flow demands within the station rating. Pumping station must have the capacity and station discharge pressure downstream of all pump system components using the number of equally sized main pumps as shown on the drawings. Provide variable frequency drive (VFD) motor controls.

C. Winterization Assembly:
   1. As presented in the installation details.
   2. Ball Valve: Use threaded carbon steel ball valve.
   3. Valve Box: Use plastic (ABS) jumbo valve box with black lid and extension. Acceptable manufacturer is Carson, Pentek, Rain Bird or approved equal.
   4. Filter Fabric: Use a spunbond polyester 3.5 oz. per square yard landscape fabric.

D. Isolation Gate Valve Assembly:
   1. As presented in the installation details.
   2. Iron body, bronze mounted, double disc with parallel or inclined seats, non-rising stem turning clockwise to close, 200 PSI minimum working pressure and mechanical joint ends meeting AWWA Standard C509. Acceptable manufacturers are NIBCO, Clow, Kennedy, Mueller or approved equal.
   3. Valve Box: Use plastic (ABS) 10-inch round valve box with black lid. Acceptable manufacturer is Carson, Pentek, Rain Bird or approved equal.
   4. Filter Fabric: Use a spunbond polyester 3.5 oz. per square yard landscape fabric.

E. Air-Vacuum Relief Valve Assembly:
   1. As presented in the installation details.
   2. Cast Iron body with epoxy coating, polypropylene float, glass fiber reinforced nylon kinetic float, Buna-N seals and O-rings, stainless steel nuts and bolts, pressure range 2 PSI to 230 PSI. Use a continuous acting combination air and vacuum and air

release valve. Acceptable manufacturer is Bermad, Crispin, Fresno, Waterman or approved equal.

3. Bronze Ball Valve: Use a valve rated to 235 PSI. Acceptable manufacturer is Nibco or approved equal.
4. Valve Box: Use plastic (ABS) jumbo rectangular valve box with black lid. Acceptable manufacturer is Carson, Pentek, Rain Bird or approved equal.
5. Filter Fabric: Use a spunbond polyester 3.5 oz. per square yard landscape fabric.

F. Quick Coupling Valve Assembly:

1. As presented in the installation details.
2. Brass construction, 1-inch nominal size, operating pressure 5-125 PSI with locking vinyl cover. Acceptable manufacturer and model is Hunter HQ-5LRC, Rain Bird 5-LRC, Toro 474-44 or approved equal.
3. Swing Joint: Use pre-manufactured triple swing joint. Acceptable manufacturer is Spears, Lasco or approved equal.
4. Quick Coupler Anchor: Use pre-manufactured bolt on anchor or swing joint integrated anchor. Acceptable manufacturers are Harco, Lasco, Spears, or approved equal.
5. Valve Box: Use plastic (ABS) 10-inch round valve box with black lid. Acceptable manufacturer is Carson, Pentek, Rain Bird or approved equal.
6. Filter Fabric: Use a spunbond polyester 3.5 oz. per square yard landscape fabric.

**2.6 SPRINKLER IRRIGATION COMPONENTS**

A. Remote Control Valve Assembly:

1. As presented in the installation details.
2. Remote Control Valve: Use a normally closed 24 VAC 50/60 cycle solenoid actuated globe pattern design. The valve pressure rating will not be less than 200 PSI. The valve body and bonnet will be constructed of heavy-duty glass-filled UV resistant nylon and have stainless steel studs and flange nuts; diaphragm will be of nylon reinforced nitrile rubber. The valve will have both internal and external manual open/close control (internal and external bleed) to manually open and close the valve without

electrically energizing the solenoid. The valve's internal bleed will prevent flooding of the valve box. The valve will house a fully encapsulated, one-piece solenoid. The solenoid will have a captured plunger with a removable retainer for easy servicing and a leverage handle for easy turning. Use 24 VAC 50/60 Hz solenoid. Valve must have a flow control stem for accurate manual regulation and/or shutoff of outlet flow. The valve must open or close in less than 1 minute at 200 PSI and less than 30 seconds at 20 PSI. The valve will have a self-cleaning stainless steel screen designed for use in dirty water applications. Provide for all internal parts to be removable from the top of the valve without disturbing the valve installation. Valve must have a pressure regulation module to regulate outlet pressure as specified. Acceptable manufacture and model is Hunter ICV Filter Sentry, Rain Bird PESB, Toro P-220 or approved equal.

3. Shut-off Valve: Use an angle valve AWWA C135 rated, ductile iron epoxy coated with stainless steel valve mechanism and restraint system. Acceptable manufacturers are Leemco LV212/218 and Harco swivel 90 lateral isolation valve.
4. PVC Union: Use a Schedule 40 threaded union with O-ring seal. Acceptable manufacturer is Spears or approved equal.
5. Valve Box: Use plastic (ABS) large valve box with black lid or combination of standard and round valve boxes with black lid. Acceptable manufacturer is Carson, Pentek, Rain Bird or approved equal.
6. Filter Fabric: Use a spunbond polyester 3.5 oz. per square yard landscape fabric.
7. Install assembly over gravel sump as presented in the installation details.
8. Wire connectors: Use 3M DBR/Y.
9. Use standard Christy I.D. tags with hot-stamped black letters on a yellow background.

B. Pop-Up Rotor Sprinkler Assembly:

1. As presented in the installation details.
2. Rotary Sprinkler: Use a gear drive sprinkler capable of covering the radius with the discharge rate at the pressure as presented

on the drawings. Furnish part circle sprinklers with an adjustable arc of 20- to 340-degrees, and full circle sprinklers with a non adjustable arc. Furnish sprinkler with stainless steel pop-down spring. Nozzle must be tested per ASAE S398.1 and be verified to deliver Distribution Uniformity of 80% or more and a Scheduling Coefficient of 1.2 or less at the specified offset spacing. Furnish sprinkler with stainless steel risers, integral check valve in base of the case capable of holding back 10 feet of elevation. Minimum pop-up height is 3 ½-inches. Acceptable manufacturer and model is Hunter I-35, Rain Bird 8005, Toro 2001 or approved equal.

3. Swing Joint: Use pre-manufactured triple swing joint. Acceptable manufacturer is Rain Bird, Spears, Lasco or approved equal.

C. Pop-Up Spray Sprinkler Assembly:

1. As presented in the installation details.
2. Spray Sprinkler: Use a spray sprinkler capable of covering the radius with the discharge rate at the pressure as presented on the drawings. Furnish sprinkler with pressure reducing module in the riser stem and integral check valve in base of the case capable of holding back a minimum of 8 feet of elevation. Minimum pop-up height is 4-inches. Acceptable manufacturer and model is Hunter Institutional Series, Rain Bird 1800-SAM-PRS, Toro 570Z-COM Series or approved equal.
3. Swing Joint: Use pre-manufactured triple swing joint with ½-inch inlet. Acceptable manufacturer is Spears, Lasco or approved equal.

**2.7 CONTROL SYSTEM COMPONENTS**

A. Control Units:

1. Provide stand alone programmable controllers capable of being upgraded for “Cloud” storage of data and central control programming in the future. Provide field units under this contract. Control unit must comply with Irrigation Association SWAT protocol testing. Acceptable manufacturers and models are ETwater Smart Box Controllers or approved equal.
2. Basic Capabilities:

a. Use preprogrammed historic evapotranspiration (ET) rate data for the area or is capable of is capable of downloading the ET data. Remote monitoring over the internet by VA staff not on site.
b. 100% solid state electrical components with heavy duty electrical lightning and surge protection for input and output circuits.
c. 24 VAC transformer capable of operating three solenoids simultaneously.
d. Built in lightning and surge protection.
e. Battery backup of at least 14 days.
f. Remote activation of remote control valves from hand held radio. Minimum number of stations required is 48.
g. Use stainless steel pedestal mount configuration.
h. Compatible with master valve and flow sensor. Capable of automatically closing master valve if a high flow condition is identified by the flow sensor.
i. Flow learning mode or programmable flow enable or disenable mode when connected to the cloud programming.

3. Rain/freeze Sensor: Use rain sensor that is compatible with control unit and can automatically shut down controller operation in a rain/freeze event.
4. Electrical conduit: Use PVC Schedule 40 conforming to the dimensions and tolerances established by ASTM Standard D-1785. Fittings for PVC conduit will be Schedule 40, Type 1, PVC solvent weld fittings, ASTM Standards D2466 and D1784.
5. Wire markers: Prenumbered or labeled with indelible nonfading ink, made of permanent, nonfading material.
6. Lightning protection: Provide one 12”x36”x0.0625” ground plate, one 5/8”x10 foot copper clad UL listed grounding rod, approximately 30 feet of #6 AWG bare copper grounding wire, two 6-inch plastic round valve boxes, and one CADWELD connector at each satellite or satellite controller group.

B. Remote Control Option:

1. Description: Hand held radio that allows operation of the irrigation for maintenance purposes via interfacing with the

control unit via handheld device on site. System to be as recommended by control unit manufacturer.

2. Basic Capabilities:
   a. Single or multi-station capability for testing.
   b. Timed station operation.
   c. Turn an irrigation program on and off.
   d. Water and mud resistant.
3. Provide three (2) handheld radios each compete with either replaceable lithium battery or rechargeable batteries and charging station.
4. Provide permanent receivers with antenna, necessary cabling and connectors in each control unit.

C. Power Wire:

1. Electric wire from the power source to satellite control unit shall be solid or stranded copper, Type TC Round Jacketed multi conductor cable with ground, direct burial, UL listed, rated at 600 volts. Power wires shall be black, white, and green in color. Size as presented in the drawings. If the control system changes, the Contractor is responsible for verifying that the power wire sizes are compatible and adequate for the control system being used.
2. Splices: Use 3M #82-A2 Series with Split Bolts or Butt Connectors for inline splices and 82-B1 or 90-B1 Series for wye splices.
3. Electrical conduit: Use PVC Schedule 40 conduit conforming to dimensions and tolerances established by ASTM Standard D-1785. Use Schedule 40, Type 1, PVC solvent weld sweep fittings for PVC conduit conforming to ASTM Standards D2466 and D1784 for buried installations. Use rigid metallic conduit with sweep elbows for above grade installations.
4. Warning tape to be installed above all power wire and communication cable, use non-detectable marking tape 4.0 mil thickness, linear low-density polyethylene, specifically formulated for extended use underground. The legend shall continually repeat a minimum of every three feet. The tape tensile strength shall be in accordance with ASTM D882 and not be

less than 4100 MD and 3650 TD. Elongation properties shall be in accordance with ASTM D882 and be greater than 550% at break point. Tape flexibility shall be in accordance with ASTM D671 and shall remain pliable. Tape composition shall be of virgin LLDPE/LDPE. The tape color shall be red. The legend shall read “Caution Electric Line Buried Below”. The tape width shall be 3-inch. Manufacturer T. Christy Enterprises, or approved equal.

D. Controller Wire:

1. Control Wire: Use American Wire Gauge (AWG) No. 14-1 solid copper, 600 volt, Type UF or PE cable, UL approved for direct underground burial for individual control wires and spare control wires from the controller assembly to each remote control valve or stub-out location. Use American Wire Gauge (AWG) No. 12-1 solid copper, 600 volt, Type UF or PE cable, UL approved for direct underground burial for common ground wire and spare common wires from controller assembly to each remote control valve or stub-out location.
2. Color: Wire color must be continuous over its entire length.
3. Splices: Use 3M DBR/Y splices as recommended by control system manufacturer.
4. Valve Box: Use plastic (ABS) standard rectangular valve with black lid. Acceptable manufacturer is Carson, Pentek, Rain Bird or approved equal.
5. Warning tape: Inert plastic film highly resistant to alkalis, acids, or other destructive chemical components likely to be encountered in soils. Three inches wide colored red and imprinted with "CAUTION: BURIED ELECTRIC LINE BELOW", in black lettering.

**2.8 OTHER COMPONENTS**

A. Tools and Spare Parts: Provide operating keys, servicing tools, spare parts and other items indicated in the General Notes of the drawings.

B. Other Materials: Provide other materials or equipment shown on the drawings or installation details that are part of the irrigation system, even though such items may not have been referenced in these specifications.

**PART 3 - PART 3 - EXECUTION**

**3.1 INSPECTIONS AND REVIEWS**

A. Site Inspections:

1. Verify construction site conditions and note irregularities affecting work of this section. Report irregularities to the Contracting Officer’s Technical Representative prior to beginning work.
2. Beginning work of this section implies acceptance of existing conditions.

B. Utility Locates ("Call Before You Dig"):

1. Arrange for and coordinate with local authorities the location of all underground utilities, and with cemetery maintenance personnel.
2. Repair any underground utilities damaged during construction. Make repairs at no additional cost to the contract price.

C. Irrigation System Layout Review: Irrigation system layout review will occur after the staking has been completed. Notify the Contracting Officer’s Technical Representative one week in advance of review. The Contracting Officer’s Technical Representative will identify modifications during this review.

**3.2 LAYOUT OF WORK**

A. Stake locations of sprinklers in existing burial sections. Use alleys as identified on the drawings.

B. Stake out the irrigation system. Items staked include: irrigation mainline pipe, thrust blocks, isolation gate valve assemblies, air/vacuum relief valve assemblies, quick coupling valves, remote control valves, lateral piping, and sprinklers.

C. If staked irrigation components conflict with utilities or other components or site features, coordinate rerouting of components with Contracting Officer’s Technical Representative.

**3.3 EXCAVATION, TRENCHING, AND BACKFILLING**

A. Excavate to permit the pipes to be laid at the intended elevations and to permit workspace for installing connections and fittings.

B. Existing Survey Markers:

1. Protect markers during construction.

2. If a survey marker is disturbed during construction, the Contractor is responsible for replacing the marker. The Contractor must hire a licensed surveyor to resurvey the location of the marker and replace it.

C. Minimum cover:
   1. 24-inches over irrigation mainline pipe in landscaped areas. (distance from top of pipe to finish grade)
   2. 18-inches over irrigation lateral pipe to sprinklers. (distance from top of pipe to finish grade)
   3. 24-inches over control wire when not in common trench with mainline or lateral piping. (distance from top of control wire to finish grade)
   4. 6-inches vertical separation between mainline pipe and lateral pipe installed in a common trench.
   5. 4-inch minimum horizontal separation between pipes and wiring in a common trench.
   6. Install sleeves at depth to maintain specified depth of pipe or wire routed through sleeve.

D. Install and maintain safety fencing around all unattended excavation. Place safety signs adjacent to construction area roadway to the satisfaction of the Contracting Officer’s Technical Representative.

E. All excavations must be backfilled by the end of each workday. Do not leave any open trenches overnight, on weekends or on holidays.

F. If trenching operation restricts access to a burial section, provide plywood and safety fencing across open trench to allow access to burial section. Provide access to the satisfaction of the Contracting Officer’s Technical Representative.

G. Excavated material is generally satisfactory for backfill. Backfill will be free from rubbish, vegetable matter, and stones larger than 2-inches in maximum dimension. Remove material not suitable for backfill. Backfill placed next to pipe will be free of sharp objects that may damage the pipe.

H. Enclose pipe and wiring beneath roadways, walks, curbs, etc in sleeves. Backfill sleeves in the following manner:
   1. Backfill trench using excavated material in 6-inch layers. Minimum compaction of backfill for sleeves shall be a minimum 95%

Standard Proctor Density, ASTM D698-78. Backfill to bottom of road base under roads or to finish grade under walks and curbs.

I. Backfill mainline, lateral pipe and wiring in turf areas in the following manner:
   1. Backfill the trench and directional boring excavations by depositing the backfill material equally on both sides of the pipe or wire in 6-inch layers and compacting to the density of surrounding soil.

J. Enclose pipe and wiring beneath roadways, walks, curbs, etc., in sleeves where it is not installed using horizontal boring techniques.

K. Dress backfilled areas to original grade. Remove excess backfill to on-site location as directed by the Contracting Officer’s Technical Representative.

L. Resod all trenches and areas disturbed by construction of the irrigation system.

M. Where utilities conflict with irrigation trenching and pipe work, contact the Contracting Officer’s Technical Representative for trench depth adjustments.

**3.4 SLEEVING AND BORING**

A. Install sleeving at a depth that permits the encased pipe or wiring to remain at the specified burial depth.

B. Extend sleeve ends a minimum of 12-inches beyond the edge of the paved surface. Cover pipe ends and mark edge of pavement with a chisel or saw.

C. Verify that sleeve sizing is adequate prior to installation. Note that sleeves required for pipe are a minimum of twice the diameter of the pipe.

D. Directional boring slurry to be diposed of legally off site by the contractor.

**3.5 ASSEMBLING PIPE AND FITTINGS**

A. General:
   1. Keep pipe free from dirt and pipe scale. Cut pipe ends square and debur. Clean pipe ends.
   2. Keep ends of assembled pipe capped. Remove caps only when necessary to continue assembly.

3. Trenches may be curved to change direction or avoid obstructions within the limits of the curvature of the pipe. Minimum radius of curvature and offset per 20-foot length of mainline and lateral pipe by pipe size are shown in the following table. All curvature results from the bending of the pipe lengths. No deflection will be allowed at a pipe joint.

| SIZE | RADIUS | OFFSET PER 20' LENGTH |
|---|---|---|
| 1 ½" | 25' | 7'-8" |
| 2" | 25' | 7'8" |
| 2 ½" | 100' | 1'-11" |
| 3" | 100' | 1'-11" |
| 4" | 100' | 1'-11" |
| 6" | 150' | 1'-4" |

B. HDPE Mainline Pipe and Fittings:

1. Join pipe lengths using butt-fusion technique as recommended by pipe manufacturer.
2. Join HDPE pipe to dissimilar pipe materials using HDPE (butt-fusion) x adapter with ductile iron back-up ring. Provide transition fitting as required for connection to dissimilar pipe material valves.

C. Lateral Pipe and Fittings:

1. PVC Solvent Weld Pipe:

a. Use primer and solvent cement. Join pipe in manner recommended by manufacturer and in accordance with accepted industry practices.
b. Cure for 30 minutes before handling and 24 hours before pressurizing or installing with vibratory plow.
c. Snake pipe from side to side within trench.

2. Fittings: The use of cross type fittings is not permitted.

D. Specialized Pipe and Fittings:

1. Mechanical joint connections: Install fittings, fasteners and gaskets in manner recommended by manufacturer and in accordance with accepted industry practices.
2. PVC Threaded Connections:
   a. Use only factory-formed threads. Field-cut threads are not permitted.
   b. Apply thread sealant in manner recommended by component, pipe and sealant manufacturers and in accordance with accepted industry practices.
   c. Use plastic components with male threads and metal components with female threads where connection is plastic-to-metal.

E. Joint Restraint Harness:

1. Install harness in the manner recommended by the manufacturer and in accordance with accepted industry practices.
2. Use restrained casing spacers for gasketed pipe routed through sleeving. Install harness in the manner recommended by the manufacturer and in accordance with accepted industry practices. Install self-restraining casing spacers at all gasketed pipe bell joints and every 10-feet along the gasketed mainline pipe installed through sleeving. Provide correct number and type of restraints per manufacturer’s requirements.

**3.6 INSTALLATION OF MAINLINE COMPONENTS**

A. Tap and Meter Assembly:

1. As presented in the installation details, per manufacturer’s instructions.
2. Install where indicated in the irrigation plans.
3. Includes flow sensor and master valve assembly, wire flow sensor and master valve to controller per manufacturers details.

4. Connect to irrigation Backflow Preventer/Booster Pump Assembly piping.

B. Backflow Preventer/Booster Pump Assembly:
1. As presented in the installation details, per manufacturer’s instructions.
2. Install where indicated in the irrigation plans.
3. Connect to irrigation mainline piping.

C. Winterization Assembly:
1. As presented in the installation details, per manufacturer’s instructions.
2. Install where indicated in the irrigation plans.
3. Brand “WA” in 2-inch high by 3/16-inch deep letters on valve box lid.

D. Isolation Gate Valve Assembly:
1. As presented in the installation details, per manufacturer’s instructions.
2. Install where indicated in the irrigation plans.
3. Brand “GV” in 2-inch high by 3/16-inch deep letters on valve box lid.

E. Air/Vacuum Relief Valve Assembly:
1. As presented in the installation details, per manufacturer’s instructions.
2. Install where indicated in the irrigation plans.
3. Brand “AV” in 2-inch high by 3/16-inch deep letters on valve box lid.

F. Quick Coupling Valve Assembly:
1. As presented in the installation details, per manufacturer’s instructions.
2. Install where indicated in the irrigation plans.
3. Brand “QC” in 2-inch high by 3/16-inch deep letters on valve box lid.

## 3.7 INSTALLATION OF SPRINKLER IRRIGATION COMPONENTS

A. Mainline Pipe Flushing:
1. Thoroughly flush mainline before installation of Remote Control Valve Assemblies.

2. Identify service tee(s) to be used for mainline flushing. Plug service tees not being used for flushing.
3. Connect 2-inch pipe to flushing service tee(s). Use pipe to direct water away from trench and into drainage swale, curb section or storm sewer, i.e. to an area that will direct the water away from the work area. Direct water so that it does not disrupt the cemetery operations or erode site.
4. Use a volume of water such that the velocity in the largest pipe flushing to this point is a minimum of 3 FPS.
5. Multiple points may be flushed simultaneously.
6. Flush for a minimum of 20 minutes. Continue flushing until the water is clear of any and all debris.
7. Contracting Officer’s Technical Representative will review the flushing operation and clarity of water before stopping the flushing operation.
8. Disconnect pipe from service tee(s) and install remote control valve(s).

B. Remote Control Valve Assembly:

1. Install per manufacturer's recommendations where indicated on the drawings.
2. Adjust valve to regulate the downstream operating pressure to 50 PSI for pop-up rotary sprinklers and 35 PSI for spray sprinklers.
3. Wire connectors and waterproof sealant will be used to connect field wire to solenoid wires. Install connectors and sealant per the manufacturer's recommendations.
4. Install only one remote control valve to a valve box. Locate valve box 5-feet from and align square with nearby edges of paved areas. Group valve boxes together where possible equidistant from the adjacent valve boxes.
5. Attach ID tag with controller station number to control wiring at solenoid.
6. Brand controller and station number in 2-inch high by 3/16-inch deep letters on valve box lid.

C. Pop-Up Rotor Sprinkler Assembly:

1. Thoroughly flush lateral pipe before installing sprinkler assembly. Water must be clear of any debris before flushing operation stops.
2. Install per the installation details at locations shown on the drawings.
3. Install rotary sprinklers 3-inches from adjacent edges of paved areas, walls or fences.
4. Install sprinklers perpendicular to the finish grade.
5. Install swing joint with the appropriate angle between the lateral pipe and the lay length nipple per the installation details.
6. Supply appropriate nozzle or adjust arc of coverage of each sprinkler for best performance.
7. Adjust the radius of throw of each sprinkler for best performance.
8. Install 2-foot square piece of sod around all rotary sprinklers in areas to be seeded.

D. Pop-Up Spray Sprinkler Assembly:

1. Thoroughly flush lateral pipe before installing sprinkler assembly. Water must be clear of any debris before flushing operation stops.
2. Install per the installation details at locations shown on the drawings.
3. Install spray sprinklers 3-inches from adjacent edges of paved areas, walls or fences.
4. Install sprinklers perpendicular to the finish grade.
5. Install swing pipe and fittings per manufacturer’s recommendations.
6. Supply appropriate nozzle or adjust arc of coverage of each sprinkler for best performance.
7. Adjust the radius of throw of each sprinkler for best performance.

## 3.8 INSTALLATION OF CONTROL SYSTEM COMPONENTS

1. Install control unit(s) at location(s) shown in the construction documents.

2. Install electrical connections per control system manufacturer's recommendations. Electrical connections are to be completed by control system manufacturer’s trained representative.
3. Lightning protection: Drive grounding rod into soil its full length. Connect #6 AWG copper grounding wire to rod and plate using CADWELD connections.
4. Attach wire markers to the ends of control wire inside controller. Label cable with the identification number per irrigation plan.
5. Install permanent receiver for hand held radio if not factory installed.
6. Install rain/freeze sensor and complete electrical connections to controller per control units manufacturer’s recommendations.
7. Create and program each new control unit with a “grow-in” and a peak season irrigation program.
8. Provide 8 hours of training for cemetery staff with manufacturer’s qualified representative.

B. Power Wire:

1. Route power wire as directed on plans. Install with a minimum number of field splices. If a power wire must be spliced, make splice with recommended connector, installed per manufacturer's recommendations. Locate all splices in a separate 12-inch standard valve box. Coil 2 feet of wire in valve box. Brand “WS” in 2-inch high by 3/16-inch deep letters on valve box lid.
2. All power wire shall be laid in trenches. The use of a vibratory plow is not permitted.
3. Green wire shall be used as the common ground wire from power source to all satellites.
4. Carefully backfill around power wire to avoid damage to wire insulation or wire connectors.
5. Unless noted on plans, install wire parallel with and below mainline pipe. Install wire a minimum 2-inches below top of PVC mainline pipe.
6. Encase wire not installed with PVC mainline pipe in electrical conduit with a continuous run of warning tape placed in the backfill, 6-inches above the wiring.

7. Surface mount wire installed above grade in a professional manner with routing approved by the Contracting Officer.
8. Connect wire to power source.

C. Control Wire:

1. Route low voltage control wire in mainline trench.
2. Provide a 24-inch excess length of wire in an 8-inch diameter loop at each 90 degree change of direction, at both ends of sleeves, and at 100-foot intervals along continuous runs of wiring. Do not tie wiring loop. Coil 24-inch length of wire within each remote control valve box.
3. If a cable must be spliced, make splice with waterproof connectors and sealant installed per the manufacturer's instructions. Locate splice in turf areas using a valve box that contains an irrigation valve assembly, or in a separate valve box. Use same procedure for connection to valves as for in-line splices. If a separate valve box is used for wire splices, brand “WS” in 2-inch high by 3/16-inch deep letters on valve box lid.
4. Unless noted on plans, install wire parallel with and below mainline pipe.
5. Protect wire not installed with pipe with a continuous run of warning tape placed in the backfill 6-inches above the wiring.

**3.9 INSTALLATION OF OTHER COMPONENTS**

A. Tools and Spare Parts:

1. Prior to the Review at completion of construction, provide operating keys, servicing tools, spare parts, and any other items indicated on the drawings.

B. Other Materials: Install other materials or equipment shown on the drawings or installation details that are part of the irrigation system, even though such items may not have been referenced in these specifications.

**3.10 MAINTENANCE AND OPERATION INSTRUCTIONS**

A. Irrigation System Maintenance:

1. Prior to Final Inspection, provide two training sessions to operating personnel on proper operation and maintenance of the irrigation and pump system. Training sessions should be for a period of not less than 8-hours each, scheduled on different days

and cover aspects of maintaining, operating and repairing the new irrigation system components. Maintenance training session cannot be concurrent with control system training sessions. Provide an additional 8-hous of prepaid training for the next two years as part of the control system support.

2. Unless otherwise noted, provide irrigation operation and maintenance information in a 3-ring binder with table of contents and index sheet. Provide sections that are indexed and labeled. Provide the following information:
   a. Catalog cut sheets for control system, valves, sprinklers, pipe and fittings, wire and wire connectors, ID tags, shop drawings, and all other irrigation equipment shown or described on the drawings and within these specifications.
   b. Manufacturer’s Operation and Maintenance manuals.
   c. Manufacturer’s Technical Service Bulletins.
   d. Manufacturer’s Warranty Documentation.
   e. Recommended routine maintenance inspections for weekly, monthly and annual inspections, recommended actions for the inspections, recommended method for recording the findings of the inspections and proper winterization techniques.
   f. Predictive schedule for component replacement.
   g. Listing of technical support contacts.
3. Operation and maintenance submittal package must be complete prior to being reviewed by the Contracting Officer’s Technical Representative. Incomplete submittals will be returned without review.

B. Control System Programming:
1. Create and program controller with a grow-in and a peak season irrigation schedule for the areas being irrigated by the controller.
2. Using the precipitation rate results of the Distribution Uniformity tests calculate the peak season run time for each station.
3. Verify operation of program.
4. Prepare a memorandum documenting the details and assumptions of the programming. Turn over memorandum to Contracting Officer’s

Technical Representative. Completion of the memorandum is a prerequisite for final inspection and operational testing of the irrigation system.

C. Colored Controller Charts:
   1. Prepare a map diagram showing location of all valves, piping, and route of the control wires. Identify all valves as to size, station, number and type of irrigation. “As-built” drawings must be approved before charts are prepared. Map diagram can be constructed using AutoCAD or PDF computer software. Adjacent lateral pipes to be of different color, use four different colors for lateral pipe.
   2. Include legend listing components used for the controller. Include a separate sprinkler table listing station number, sprinkler manufacturer and model, zone capacity, and number of sprinklers on the zone.
   3. Provide one colored full sized controller chart for each irrigation plan sheet showing the area covered by the controller. Provide four 11”x17” reduced colored charts of the actual “as-built” drawing. Chart must be readable at the reduced size.
   4. Laminate one 11”x17” sized colored chart and place laminated chart in lid of each controller.

**3.11 PROJECT RECORD DRAWINGS**

A. The Contractor is responsible for documenting installed system and all changes to the design. Maintain on-site and separate from documents used for construction, two complete sets of contract documents as Project Documents. Keep documents current. Do not permanently cover work until as-built information is recorded on Project Documents.

B. Record irrigation components, pipe and wiring network alterations. Record work that is installed differently than shown on the construction drawings. Special attention must be given to pipe routing and controller stationing.

C. At completion of installation, Contractor must hire a Professional Licensed Surveyor to survey/document locations of all sprinklers, irrigation components enclosed within a valve box, controllers, flower water stations, wire splice boxes and “coordination points”. If necessary, Contractor must flag sprinklers for Surveyor. Surveyor must

use “SPR” as attribute data for sprinklers, the branding in the valve box lid (for example “GV”, “AV”, “QC”) as the attribute data for components enclosed within a valve box, “CTLR” as the attribute data for controllers, “FWS” for flower water station, “WS” for wire splice boxes and “CP” for coordination points. Contracting Officer’s Technical Representative will provide AutoCAD file for Surveyor showing coordination points to produce “Survey Drawing”. Surveyor is to use the AutoCAD files to develop and provide an AutoCAD file and PDF file of the Survey Drawing.

D. Prior to project completion, Contractor must provide the project redline drawings and the “Survey Drawing” AutoCAD files to Contracting Officer’s Technical Representative for delivery to VA’s A/E representative. A/E will prepare “Record Drawings” by compiling the information on the Contractor redlines drawings and the “Survey Drawing”. Provision of this information prerequisite for Final Inspection.

E. Prior to project completion provide 1 30” X 42” laminated drawing of the entire system for wall mount, drawing need not be to scale.

**3.12 MAINTENANCE**

A. Operate and maintain irrigation system for a duration of 30 calendar days from Final acceptance. Make periodic examinations and adjustments to irrigation system components so as to achieve the most desirable application of water.

**3.13 CLEANUP**

A. Upon completion of work, remove from the site all machinery, tools, excess materials, and rubbish. Restore site to normal or original condition.

- - - END - - -

B. Certificates of Conformance or Compliance: Before delivery, notarized certificates attesting that the following materials meet the requirements specified shall be submitted to the Contracting Officers Technical Representative for approval:
   1. Fertilizers.
   2. Sod

**1.5 DELIVERY AND STORAGE**

A. Delivery:
   1. Notify the Contracting Officers Technical Representative of the delivery schedule in advance so the plant material may be inspected upon arrival at the job site. Remove unacceptable plant material from the job site immediately.
   2. Deliver fertilizer to the site in the original, unopened containers bearing the manufacturer's guaranteed chemical analysis, name, trade name or trademark, and in conformance to state and federal law. In lieu of containers, fertilizer may be furnished in bulk and a certificate indicating the above information shall accompany each delivery.
   3. During delivery: Protect sod from drying out.

B. Storage:
   1. Sprinkle sod with water and cover with moist burlap, straw or other approved covering, and protect from exposure to wind and direct sunlight. Covering should permit air circulation to alleviate heat development.
   2. Keep fertilizer in dry storage away from contaminants.

**1.6 TURFGRASS INSTALLATION SEASONS AND CONDITIONS**

A. Perform sod installation operations within the following dates, but not before irrigation system installed, tested, and approved.
   1. Spring Planting: April 1 to June 1.
   2. Fall Planting: September 1 to November 15.

B. No work shall be done when the ground is too wet, frozen or in an otherwise unsuitable condition for planting. Special conditions may exist that warrants a variance in the specified planting dates or conditions. Submit a written request to the Contracting Officers Technical Representative stating the special conditions and proposal variance.

**1.7 TURF ESTABLISHMENT PERIOD**

A. The Establishment Period for turf shall begin immediately after installation, with the approval of the Contracting Officers Technical Representative, and continue until the date that the Government accepts the project or phase for beneficial use and occupancy. During the Turf Establishment Period the Contractor shall:

1. Water turf to maintain an adequate supply of moisture within the root zone. An adequate supply of moisture is the equivalent of 1 inch of absorbed water per week either through natural rainfall or augmented by periodic watering. Apply water at a moderate rate so as not to displace or flood the turf.
2. Provide the following turf establishment:
   a. Eradicate all weeds. Water, fertilize, and perform any other operation necessary to promote the growth of grass.
   b. Replant areas void of turf one square foot and larger in area.
   c. Mow the new lawn at least three times prior to the final inspection. Begin mowing when grass is 4 inches high. Mow to a 2-1/2 inch height.

**1.8 TURFGRASS ACCEPTANCE.**

A. Turfgrass acceptance will occur after completion of the TURFGRASS ESTABLISHMENT PERIOD. The Contractor shall have completed, located, and installed all turfgrass according to the plans and specifications. All turfgrass are expected to be living and in a healthy condition at the time of inspection and acceptance. The Contractor shall make a written request two weeks prior to final inspection of the turfgrass. Upon inspection when work is found to not meet the specifications, the TURFGRASS ESTABLISHMENT PERIOD shall be extended at no additional cost to the Government until work has been satisfactorily completed, inspected and accepted.

B. Criteria for acceptance of turfgrass shall be as follows:

1. A satisfactory stand of grass plants from the sod operation shall be living sod uniform in color and leaf texture and well rooted into the soil below so that gentle pulling of the turfgrass leaves by hand does not dislodge the sod. Bare spots shall be a maximum two (2) square inches. Joints between sod pieces shall be tight and free from weeds and other undesirable growth.

**1.9 TURF WARRANTY**

A. The purpose of this warranty is to insure that the Government receives turf of prime quality, installed and maintained in a thorough and careful manner.
   1. A One Year Turf Warranty will begin on the date that the Government accepts the project or phase for beneficial use and occupancy. The Contractor shall have completed, located, and installed all turf according to the plans and specifications. All turf are expected to be living and in a healthy condition at the time of final inspection.
   2. The Contractor will replace any areas void of turf immediately. A one year warranty for the turf that was replaced will begin on the day the work is completed.
   3. The Government will reinspect all turf at the end of the One Year Warranty. The Contractor will replace any dead, missing, or defective turf immediately. The Warranty will end on the date of this inspection provided the Contractor has complied with the work required by this specification. The Contractor shall also comply with the following requirements:
      a. Replace dead, missing or defective plant material prior to final inspection.
      b. Complete remedial measures directed by the Contracting Officers Technical Representative to ensure turf survival.
      c. Repair damage caused while making turf replacements.

**1.10 APPLICABLE PUBLICATIONS**

A. NCA Handbook 3420 – Turfgrass Maintenance in VA National Cemeteries re-certified 2011. The Agronomic and Horticultural practices specified in this handbook shall serve as the contractor’s official reference guide to all establishment and preliminary maintenance practices employed during this construction project.

B. The publications listed below, form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.

C. Hortus Third, most current edition. A Concise Dictionary of Plants Cultivated in the U.S. and Canada.

D. Turfgrass Producers International: Turfgrass Sodding.

## PART 2 - PRODUCTS

### 2.1 GENERAL

All turfgrass material will conform to the varieties specified and be true to botanical name as listed in Hortus Third.

### 2.2 SOD

A. Sod shall be locally nursery grown, certified sod as classified in the TPI Guideline Specifications to Turfgrass Sodding.

B. Sod must also conform to the current sod species mix being installed at Camp Butler National Cemetery.

| Seed | Purity | Germination |
|---|---|---|
| 1. Species 1: Bar FA RFT Tall Fescue | 59.52% | 90.00% |
| 2. Species 2: Barvado Tall Fescue | 19.78% | 90.00% |
| 3. Species 3: Barrabusto Tall Fescue | 14.8% | 90.00% |
| 4. Species 4: Barister Kentuck Bluegrass | 4.94% | 85.00% |

### 2.3 TOPSOIL

A. Reuse existing topsoil exposed during trenching. Topsoil must be free of admixture of subsoil, foreign matter, objects larger than one-inch in any dimension, toxic substances, weeds and any material or substances that may be harmful to plant growth.

B. If sufficient topsoil is not available on the site to meet the depth as specified herein, the Contractor shall furnish additional topsoil. At least 10 days prior to topsoil delivery, notify the Contracting Officers Technical Representative of the source(s) from which topsoil is to be furnished. Obtain topsoil from well drained areas. Additional topsoil shall meet the general requirements as stated above and comply with the requirements specified in Section 01 45 29, TESTING LABORATORY SERVICES.

### 2.4 TURF FERTILIZER

Provide turf fertilizer that is commercial grade, free flowing, uniform in composition, and conforms to applicable state and federal regulations. Granular fertilizer shall bear the manufacturer's warrantee statement of analysis. Granular fertilizer shall conform to the requirements shown on the Drawings.

## PART 3 - EXECUTION

### 3.1 SODDING OF IRRIGATION TRENCHES AND EXCAVATION

A. Resod all area disturbed by irrigation trenches and/or areas disturbed by irrigation system construction and excavation.

B. Compact all trenches as specified in Specification 32 84 00 Planting Irrigation.

C. Allow excavated area to settle for a minimum of 7 days.

D. Using a sod cutter, cut over trench or excavation to proper depth and width for sod.

E. Accomplish sodding in accordance with the ASPA Guideline Specifications for sodding. Lay sod lengthwise along trenches to minimize the number of joints. On slope areas, start at the bottom of the slope.

F. After completing the sodding operation, blend the edges of the sodded area smoothly into the surrounding area. All sod should be rolled with a light- weight roller after being laid to eliminate air spaces between the sod and the firmed soil.

**3.2 APPLICATION OF FERTILIZER FOR TURF AREAS**

A. Apply turf fertilizer to newly sodded areas at the rate recommended by Sod Grower.

**3.3 WATERING**

Apply water to the turf areas immediately following installation at a rate sufficient to ensure thorough wetting of the soil to a depth of at least 2 inches. Supervise watering operation to prevent run-off. Repair all areas damaged by water operations. Keep soil surface constantly moist, not wet, until turfgrass is well established.

**3.4 PROTECTION OF TURF AREAS**

Immediately after installation of the turf areas, protect against traffic or other use by erecting barricades, as required, and placing approved signs at appropriate intervals until final acceptance.

**3.5 RESTORATION AND CLEAN-UP**

Where existing or new turf areas have been damaged or scarred during planting and construction operations, restore disturbed area to their original condition. Keep at least one paved pedestrian access route and one paved vehicular access route to each building clean at all times. In areas where planting and turf work have been completed, clear the area of all debris, spoil piles, and containers. Clear all other paved areas when work in adjacent areas is completed. Remove all debris, rubbish and excess material from the station.

**3.6 ENVIRONMENTAL PROTECTION**

All work and Contractor operations shall comply with the requirements of Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

- - - E N D - - -

**APENDIX A**

DETAILED SCHEDULE OF VALUES FOR IRRIGATION COMPONENTS

**Camp Butler National Cemetery - Irrigate Entire Cemetery** **1/8/2014**
**VA Project Number: 806CM3024**
**Final Construction Document**

**Base Bid Item 1 (A,5): Detailed Schedule of Values for Irrigation Components**

Upon award of the project the Contractor will be required to complete the following schedule of values for primary components of the irrigation project. Values shall include material cost, labor and installation for a complete installed element. The items listed on this form are not all inclusive of the proposed scope of work identified in the construction documents. Additional items may be requested by the VA to be included in the project schedule of values.

**Submitted By:**

Contractor:

Address:

Date:

| | | DESCRIPTION | QUAN. | UNIT | UNIT COST | TOTAL | |
|---|---|---|---|---|---|---|---|
| | | **IRRIGATION** | | | | | |
| | | 6-INCH IRRIGATION WATER TAP/METER | | LS | | | |
| | | WINTERIZATION ASSEMBLY | | EA | | | |
| | | BACKFLOW ASSEMBLY | | EA | | | |
| | | BOOSTER PUMP ASSEMBLY | | EA | | | |
| | | ISOLATION GATE VALVE ASSEMBLY | | EA | | | |
| | | AIR VACUUM RELIEF VALVE ASSEMBLY | | EA | | | |
| | | MANUAL DRAIN VALVE ASSEMBLY | | EA | | | |
| | | QUICK COUPLING VALVE ASSEMBLY | | EA | | | |
| | | REMOTE CONTROL VALVE ASSEMBLY | | EA | | | |
| | | POP-UP SPRAY SPRINKLER ASSEMBLY | | EA | | | |
| | | POP-UP ROTOR SPRINKLER ASSEMBLY | | EA | | | |
| | | HORIZONTAL BORING | | LF | | | |
| | | 8-INCH MAINLINE PIPE | | LF | | | |
| | | 6-INCH MAINLINE PIPE | | LF | | | |
| | | 4-INCH MAINLINE PIPE | | LF | | | |
| | | 3-INCH MAINLINE PIPE | | LF | | | |
| | | 3-INCH LATERAL PIPE | | LF | | | |
| | | 2-1/2-INCH LATERAL PIPE | | LF | | | |
| | | 2-INCH LATERAL PIPE | | LF | | | |
| | | 1-1/2-INCH LATERAL PIPE | | LF | | | |
| | | 1-1/4-INCH LATERAL PIPE | | LF | | | |
| | | 1-INCH LATERAL PIPE | | LF | | | |
| | | CONTROL WIRE | | LF | | | |
| | | SATELLITE CONTROLLERS | | EA | | | |
| | | ELECTRICAL | | LS | | | |
| | | SOD IRRIGATION TRENCHES | | LF | | | |
| | | MANUAL TRENCHING | | LF | | | |
| | | CONSTRUCTION ACCESS DRIVE, 500' | | SF | | | |